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DIVISION 400 – Bituminous Pavements

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Section 401 - Major Hot Asphalt Concrete Pavement With Pay Factor

Description

401.01 Work. Construct one or more courses of hot asphalt concrete pavement as SHOWN ON THE DRAWINGS. Have the surface approved in writing by the CO before placing the hot asphalt concrete pavement.

Hot asphalt concrete pavement classes are designated as shown in Table 401-1. Hot asphalt concrete pavement aggregate grading is designated as shown in Table 703-4. State asphalt concrete pavement classes are designated by local State department of transportation designations. Superpave asphalt concrete pavement nominal size and grading are designated as shown in Table 703-10, 703-11, or 703-12.

Table 401-1 – Asphalt concrete mixture requirements.

Design Parameters	Class of Mixture		
	A	B	C
(a) Hveem (AASHTO T 246 and T 247):			
(1) Stabilometer, min.	37	35	30
(2) Air voids, %[a]	3-5	3-5	3-5
(3) Voids in Mineral Aggregate (VMA) min %	**See Table 401-2**		
(b) Marshall (AASHTO T 245):[b]			
(1) Stability, lbs min.	1,800	1,200	1,000
(2) Flow, 0.01 in	8 - 14	8 - 16	8 - 20
(3) Air voids, %[a]	3-5	3-5	3-5
(4) Voids in Mineral Aggregate, min %	**See Table 401-2**		
(5) Compaction, number of blows each end of test specimen	75	50	50
(c) Immersion-Compression (AASHTO T 165 and T 167):			
(1) Compressive strength, min. psi	300	250	200
(2) Retained strength, min %	70	70	70
(d) Root-Tunnicliff (AASHTO D 4867):			
(1) Tensile strength ratio, min %	70	70	70
(e) Dust/asphalt ratio[c]	0.6 - 1.3	0.6 - 1.3	0.6 - 1.3

[a] The percent of air voids is based on AASHTO T 166, AASHTO T 209, and AASHTO T 269. Maximum specific gravity will be based on AASHTO T 209.
[b] Following mixing, asphalt cement mixtures will be cured in an oven maintained at 55 °F to 65 °F above the compaction temperature for 90 ± 10 minutes.
[c] Dust/asphalt ration is defined as the percent of material, including nonliquid antistrip and mineral filler, that passes the No. 200 sieve, divided by the percent of asphalt (calculated by mass of mix).

Asphalt cement grade is designated as shown in AASHTO M 20, M 226, or MP 1, or in applicable State department of transportation specifications for asphalt materials for the grade specified.

A prepaving conference will be held at least 10 working days prior to the beginning of paving operations. At that time, the Contractor and the CO will discuss methods of accomplishing all phases of the paving work, including laydown operations, work

schedules, work force, quality control systems, spill prevention and contingency plans, and asphalt concrete mix delivery.

Table 401-2. - Voids for Mineral Aggregate (VMA), Marshall, Hveem, Superpave Mix Design

Sieve Size[a] (inch)	Minimum Voids [(b)(c)] Percent		
	Marshall	Hveem	Superpave
No. 8	21	19	-
No. 4	18	16	-
3/8	16	14	15
½	15	13	14
¾	14	12	13
1	13	11	12
1 1/2	12	10	11
2	11.5	9.5	10.5

[a] The largest sieve size listed in the applicable specifications upon which any material is permitted to be retained.
[b] VMA to be determined in accordance with Asphalt Institute (AI) Manual Series number 2 (MS-2).
[c] When a mineral filler or nonliquid antistrip is use, include the percentage specified in the calculation for compliance with the VMA.

Materials

401.02 Requirements. Ensure that material conforms to specifications in the following subsections:

Antistrip Additive 702.07
Asphalt Cement.....702.01
Hot Asphalt Concrete Pavement Aggregate 703.07
Mineral Filler 725.05
Recycling Agent 702.05
Superpave Asphalt Concrete Pavement Aggregate ...703.14

Ensure that reclaimed asphalt pavement material conforms to the following:

(a) 100 percent passes the 2-inch screen.

(b) The material consists of asphalt cement and asphalt cement-coated aggregate.

Construction

401.03 Composition of Mixture (Job-Mix Formula). Up to 20 percent reclaimed asphalt pavement material may be used, subject to approval of a Contractor quality control plan and submission of test data demonstrating that the mixture will meet the requirements specified in this section.

Furnish the appropriate mixture as follows:

(a) Hot Asphalt Concrete Pavement Mixture. Furnish aggregate, asphalt, additives, and, when applicable, reclaimed asphalt pavement material that meet the applicable aggregate gradation requirement shown in Table 703-4, and design parameters (a) or (b); (c) or (d); and (e) shown in Table 401-1.

(b) Superpave Asphalt Concrete Pavement Mixture. Furnish aggregate, asphalt, and additives that meet applicable gradation and material requirements specified in Subsection 703.14, and the appropriate design parameters shown in Tables 401-2 and 401-2A. Compact specimens with the gyratory compactive effort specified in Table 401-2B for the specified air temperature as SHOWN ON THE DRAWINGS.

Table 401-2A. - Superpave asphalt concrete mixture requirements.

Design Parameters	Requirements
Percent air voids at design gyrations, N_{des}	4.0
Percent maximum density at initial gyrations, N_{init}	89 max.
Percent maximum density at maximum gyrations, N_{max}	98 max.
Tensile strength ratio (AASHTO T 283)	80 min.
Voids Filled With Asphalt	70 - 80%
Dust/asphalt ratio[a]	0.6 – 1.2

[a] Dust/asphalt ratio is defined as the percent of material passing the No. 200 sieve, divided by the effective asphalt content as calculated by weight of mix.

Table 401-2B. - Gyratory compactive effort.

Average Design High Air Temperature	N_{init}	N_{des}	N_{max}
< 102 °F	7	68	104
102 – 104 °F	7	74	114
105 - 108 °F	7	78	121
109 - 111 °F	7	82	127

(c) State Asphalt Concrete Pavement Mixture. Furnish aggregate, asphalt, and additives that meet the applicable aggregate gradation and aggregate quality specified by the local State department of transportation, and design parameters (a) or (b); (c) or (d); and (e) shown in Table 401-1. Local State department of transportation design parameters in lieu of those shown in Table 401-1 may be used if approved by the CO.

Submit written job-mix formulas for approval at least 21 days before production. For each job-mix formula, submit the following:

(1) Aggregate and mineral filler, including:

(a) TV for percent passing each sieve size for the aggregate blend. Ensure that the gradation of the blended aggregate and reclaimed asphalt pavement material falls within the gradation band for each sieve size designated in the specified grading.

(b) Source and percentage of each aggregate stockpile to be used.

(c) Average gradation of each aggregate stockpile.

(d) Results of aggregate quality tests.

(e) Samples, when SHOWN ON THE DRAWINGS.

(2) Asphalt cement, including:

(a) TV for percent of asphalt cement based on total weight of mix.

(b) Recent quality test results from the manufacturer for the asphalt cement, including a temperature/viscosity curve.

(c) Material safety data sheets.

(d) Samples, when SHOWN ON THE DRAWINGS.

(3) Antistrip additives. When applicable, furnish:

(a) Type and TV for percent of antistrip additive.

(b) Material safety data sheet.

(c) Samples, when SHOWN ON THE DRAWINGS.

(4) Mix temperatures, including:

(a) Temperature leaving the mixer.

(b) Temperature immediately preceding initial compaction.

(5) Maximum specific gravity, determined according to AASHTO T 209 at the asphalt cement TV.

(6) Reclaimed asphalt pavement material; when applicable, the percent reclaimed asphalt pavement material and the type and percent of recycling agent.

(7) Asphalt mixtures; when applicable, the location of all commercial mixing plants to be used. A job-mix formula is needed for each plant.

The CO will evaluate the suitability of the material and the proposed job-mix formula. After reviewing the proposed job-mix formula, the CO will develop a TV for the asphalt cement content and determine the need for antistrip additive, the specific gravity in accordance with AASHTO T 209, and the discharge temperature range.

If a job-mix formula is rejected, submit a new job-mix formula as described above.

Changes to an approved job-mix formula require approval before production. Allow up to 14 days to evaluate a change. Approved changes in TV's will not be applied retroactively for payment.

401.04 Mixing Plant. Use mixing plants that conform to ASTM D 995, unless producing approved material for a local State department of transportation. Supplement mixing plant as follows:

(a) All Plants. For all plants, use:

(1) Automated Controls. Automatically control the proportioning, mixing, and discharging of the mixture.

(2) Emission Controls. If a wet scrubber is used, circulate the collected material though sludge pits or settling tanks. Remove the resultant sediment from the project or bury according to Subsection 202.04.

(b) Drum Dryer-Mixer Plants. For drum dryer-mixer plants, use:

(1) Bins. Provide a separate bin in the cold aggregate feeder for each individual aggregate stockpile in the mixture. Use bins of sufficient size to keep the plant in continuous operation, and of proper design to prevent overflow of material from one bin to another.

(2) Stockpiling Procedures. Separate aggregate into at least two stockpiles with different gradations. At a minimum, designate one stockpile to contain mostly coarse material, and one stockpile to contain mostly fine material. Stockpile material according to Subsections 305.03 and 305.04.

(3) Reclaimed Asphalt Pavement Material. Modify drum dryer-mixer plants to prevent direct contact of the reclaimed asphalt pavement material with the burner flame and to prevent overheating of the reclaimed asphalt pavement material. Stockpile the material according to Subsection 305.03 and 305.04.

(c) Batch & Continuous Mix Plants. For batch and continuous mix plants, use:

(1) A Hot Aggregate Bin. Provide a bin with three or more separate compartments for storage of the screened aggregate fractions to be combined for the mixture. Make the partitions between the compartments tight and of sufficient height to prevent spillage of aggregate from one compartment into another.

(2) Load Cells. Calibrated load cells instead of scales may be used in batch plants.

(3) Reclaimed Asphalt Pavement Material. Modify batch plants to allow the introduction of reclaimed asphalt pavement material into the mixture using methods that bypass the dryer. Design the cold feed bin, conveyor system, and special bin adjacent to the weigh hopper, if used, to avoid segregation and sticking of the reclaimed asphalt pavement material. Heat the new aggregate and/or reclaimed aggregate material to a temperature

that will transfer sufficient heat to the reclaimed asphalt pavement material to produce a mix of uniform temperature within the range specified in the approved job-mix formula.

401.05 Pavers. Use pavers that are:

(a) Self-contained, power-propelled units with adjustable vibratory screeds with full-width screw augers.

(b) Heated for the full width of the screed.

(c) Capable of spreading and finishing courses of asphalt mixture in widths at east 12 inches more than the width of one lane.

(d) Equipped with a receiving hopper with sufficient capacity to ensure a uniform spreading operation.

(e) Equipped with automatic feed controls that are properly adjusted to maintain a uniform depth of material ahead of the screed.

(f) Capable of being operated at forward speeds consistent with satisfactory laying of the mixture.

(g) Capable of producing a finished surface with the required smoothness and texture without segregating, tearing, shoving, or gouging the mixture.

(h) Equipped with automatic screed controls with sensors capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals that operate the screed to maintain grade and transverse slope.

401.06 Surface Preparation. Prepare the surface in accordance with Section 304, 306, 307, or 308, as applicable. Apply an asphalt tack coat to contact surfaces of curbing, gutters, manholes, and other structures, in accordance with Section 407.

401.07 Weather Limitations. Place hot asphalt concrete pavement on a dry, unfrozen surface when the air temperature in the shade is above 35 °F and rising, and when the temperature of the road surface in the shade, the lift thickness, and the minimum laydown temperature are as shown in Table 401-3.

401.08 Asphalt Preparation. Uniformly heat the asphalt cement to provide a continuous supply of the heated asphalt cement from storage to the mixer. Do not heat asphalt cement above 350 °F.

If the job-mix formula requires a liquid heat-stable antistrip additive, meter it into the asphalt cement transfer lines at a bulk terminal or mixing plant. Inject the additive for at least 80 percent of the transfer or mixing time to obtain uniformity.

Table 401-3. - Minimum laydown temperature[a] for hot asphalt concrete mixture placement (^{o}F)

Lift Thickness (inches)	< 2	2 – 3	> 3
Road Surface Temperature (^{o}F)	**Minimum Lay-Down Temperatures (^{o}F)**		
<35	-[b]	-[b]	-[b]
35 – 39.9	-[b]	-[b]	280
40 – 49.9	-[b]	285	275
50 – 59.9	295	280	270
60 – 69.9	285	275	265
70 – 79.9	280	270	265
80 – 89.9	270	265	260
≥ 90	265	260	255

[a] Never heat the asphalt concrete mixture above the temperature specified in the approved mix design.
[b] Paving not allowed.

401.09 Aggregate Preparation. If nonliquid antistrip is used, adjust the aggregate moisture to at least 4 percent by weight of aggregate. Mix the antistrip uniformly with the aggregate before introducing the aggregate into the dryer or dryer drum. Use calibrated weighing or metering devices to measure the amount of antistrip and moisture added to the aggregate.

For batch plants, heat, dry, and deliver aggregate for pugmill mixing at a temperature sufficient to produce a mixture temperature within the approved range. Adjust flames used for drying and heating to prevent damage to and contamination of the aggregate.

Control plant operations so the moisture content of the mixture behind the paver is 1/2 percent or less, in accordance with AASHTO T 110.

401.10 Mixing. Measure the aggregate and asphalt into the mixer in accordance with the approved job-mix formula. Mix until all the particles are completely and uniformly coated with asphalt, in accordance with ASTM D 995. Maintain the discharge temperature within the approved range.

401.11 Hauling. Use vehicles with tight, clean, and smooth metal beds for hauling asphalt concrete mixtures.

Thinly coat the beds with an approved material to prevent the mixture from adhering to the beds. Do not use petroleum derivatives or other coating material that contaminates or alters the characteristics of the mixture. Drain the bed before loading.

Equip each truck with a canvas cover or other suitable material of sufficient size to protect the mixture from the weather. When necessary to maintain temperature, use insulated truck beds and securely fastened covers. Provide access ports or holes for checking the temperature of the asphalt mixture in the truck.

401.12 Placing & Finishing. Do not use mixtures produced from different plants unless the mixtures are produced in accordance with the same job-mix formula, contain material from the same sources, and are approved.

Place asphalt concrete mixture at a temperature conforming to Table 401-3. Measure temperature of the mixture in the hauling vehicle just before dumping into spreader, or measure it in the windrow immediately before pickup.

Place the mixture with a paver that conforms to specifications in Subsection 401.05. Control horizontal alignment using a reference line. Automatically control the grade and slope from reference lines, a ski and slope control device, dual skis. Use skis with a minimum length of 20 feet.

Limit the compacted thickness to 3 inches, unless otherwise SHOWN ON THE DRAWINGS.

On areas where mechanical spreading and finishing is impractical, place and finish the mixture with other equipment to produce a uniform surface closely matching the surface obtained when using a mechanical paver.

Offset the longitudinal joint of one layer at least 6 inches from the joint in the layer immediately below. Make the longitudinal joint in the top layer along the centerline of two-lane roadways, or at the lane lines of roadways with more than two lanes. Offset transverse joints in adjacent lanes and in multiple lifts by at least 10 feet.

The CO will designate the job-mix formula to be used for wedge and leveling courses at each location unless DESIGNATED IN THE SCHEDULE OF ITEMS. Place wedge and leveling courses in maximum 3 inch lifts and compact with a pneumatic-tire roller meeting the requirements of Subsection 203.15(d). Complete the wedge and leveling before starting normal paving operations.

401.13 Compacting. Furnish at least three rollers, one each for breakdown, intermediate, and finish rolling. Furnish at least one roller with pneumatic tires. Size the rollers to achieve the required results. Operate rollers in accordance with manufacturer's recommendations.

Thoroughly and uniformly compact the asphalt surface by rolling. Do not cause undue displacement, cracking, or shoving. Continue rolling until all roller ridges, ruts, and humps are eliminated and the required compaction is obtained. Do not vibratory roll the mixture after its surface cools below 175 °F.

Along forms, curbs, headers, walls, and other places not accessible to the rollers, compact the mixture with other equipment to obtain the minimum compaction.

401.14 Joints, Trimming Edges, & Cleanup. At connections to existing pavements and previously placed lifts, make the transverse joints vertical to the depth of the new pavement. Form transverse joints by cutting back on the previous run to expose the full

depth course. Dispose of trimmed asphalt material in accordance with Subsection 202.04 (a).

Apply an asphalt tack coat to the edge of the joint for both transverse and longitudinal joints, and where SHOWN ON THE DRAWINGS, in accordance with Section 407.

Place the asphalt concrete mixture as continuously as possible. Do not pass rollers over the unprotected end of a freshly laid mixture.

401.15 Acceptance. Provide a quality control plan and then sample, test, and maintain records according to Section 160. See Table 401-4 for minimum sampling and testing requirements.

- The sample size is adequate to provide a duplicate to the CO and to meet potential need for retesting as specified in Subsection 401.18.

- Samples are prepared according to AASHTO T 248 or other procedures applicable to the item being sampled.

- The sample is adequately identified and placed in CO-approved containers provided by the Contractor.

The CO may perform quality assurance testing, and these tests will be made available to the Contractor upon request.

A lot is defined as the number of tons of material or work produced and/or placed under one set of TV's. The lot will be represented by randomly selected samples tested for acceptance. Plant and equipment operators will not be advised ahead of time when samples are taken.

Acceptance will be evaluated as follows:

(a) Asphalt Cement. Asphalt cement will be evaluated for acceptance under Subsection 106.05.

(b) Pavement Smoothness. Use a 10 foot metal straightedge to measure at right angles and parallel to the centerline at designated sites. Defective areas are surface deviations in excess of 3/8 inch between any two contacts of the straightedge with the surface. Correct defective areas using approved methods.

(c) Thickness & Width. Ensure that the thickness and width of the compacted mixture conform to the dimensions SHOWN ON THE DRAWINGS and meet the following requirements:

(1) The maximum variation from the specified thickness is less than 1/4 inch for the wearing course or 1/2 inch for the base course.

(2) The compacted width has a (+) 6 inch tolerance.

(3) The compacted thickness and width are not consistently above or below the specified dimensions.

Table 401-4. - Sampling and testing.

Type of acceptance	Material or Product	Property or Characteristic	Test Method or Specification	Frequency	Sampling Point
Production certification (subsection 105.04)	Asphalt cement	Contract requirements	AASHTO M 20, M 226, or MP 1, as applicable	Daily	-
Tested conformance	Material source	Los Angeles abrasion	AASHTO T 96	Three times for each undeveloped source, [b] or once for all other sources	Material source
		Sodium sulfate soundness loss	AASHTO T 104		
		Durability index (course and fine)	AASHTO T 210		
	Aggregate	Fractured faces (course)[a]	FLH T 507		Cold feed prior to entering dryer
		Sand equivalent Value (fine)	AASHTO T 176 Alternate method Number 2 (referee method)		
	Asphalt cement	Sample	Subsection 105.04(b)	Once for each 500 tons of mix, and not more than three times per day	At point of shipment delivery
	Job-mix formula	Contract requirements	Subsection 401.03	Once for each product or material change	-
Mix evaluation	Hot asphalt concrete pavement	Asphalt content	AASHTO T 164 Method B or E	Once for each 500 tons, not more than three times per day	At plant, in hauling units, or behind laydown machine before rolling
		Gradation	AASHTO T 30		
		Compaction	ASTM D 2950, "Procedure"	Five times for each 500 ton, and not less than five times per day	In-place after compaction
		Maximum specific gravity	AASHTO T 209	Once for each 1,000 ton	At plant, in hauling units, or behind laydown machine before rolling

[a] Use only for gravel sources.
[b] An undeveloped source is a source that has not supplied aggregate for asphalt concrete within 365 days of the start of producing asphalt concrete for this particular project.

(d) Asphalt Concrete Mixture Gradation and Asphalt Content. Gradation and asphalt content will be evaluated for acceptance under Subsection 401.16.

(e) Asphalt Concrete Pavement Compaction. Compaction will be evaluated for acceptance under Subsection 401.17.

401.16 Acceptance Sampling & Testing of Asphalt Concrete Mixture Gradation & Asphalt Content. Take statistically random samples in accordance with the tests specified in Table 401-4. Take a minimum of three tests per lot. Acceptance or rejection of completed work will be on a lot basis. If the Contractor's quality control tests required in Table 401-4 are validated by the CO in accordance with Subsection 401.18 (Test Result Validation Procedure), then the Contractor's tests will be used for acceptance tests.

Obtain samples of the mixture at the plant in approved State department of transportation sampling devices, or after the mixture has been discharged into hauling units or placed on the road in accordance with AASHTO T 168. Test samples for asphalt content by means of AASHTO T 164, method B (Reflux Method) or method E (Vacuum Extraction). Other methods, including nuclear, require approval in writing by the CO and may require an increased sampling and testing frequency. Report the asphalt content to the nearest 0.01 percent. Determine gradation of the entire quantity of extracted material in accordance with AASHTO T 30, except that results shall be reported to the nearest 0.1 percent for all sieves except the No. 200 sieve. Report this sieve to the nearest 0.01 percent. Determine the percent moisture in the asphalt mixture in accordance with AASHTO T 110.

If samples are tested for asphalt content by means of AASHTO T 164, determine an Extraction Retention Factor based on the average difference between at least three samples of known asphalt content, and corresponding asphalt content by the same procedure that will be used for acceptance. Prepare the samples in accordance with Table 401-1, (b) Marshall, unless otherwise approved by the CO.

If areas of isolated defect are identified by the CO, treat these areas as a separate lot.

The mix tolerance, also referred to as the upper and lower specification limits (USL's and LSL's), is as shown in Table 401-5. For Superpave asphalt concrete pavement, the sieve tolerances will follow the allowable deviations in Subsection 703.14 for the designated nominal size.

Table 401-5. - Mix tolerances.

Mixture Characteristic	Tolerances
Bitumen Content	TV $\pm$ 0.5
Sieve size:	
No. 4 and larger	TV $\pm$ 6.0
No. 30 to No. 4	TV $\pm$ 4.0
No. 50 to No. 30	TV $\pm$ 3.0
No. 200 to No. 50	TV $\pm$ 2.0

The Contractor may request a change in TV's subject to the provisions in Subsection 401.03. If the TV's are changed, evaluate all of the material produced up to the time of the change as a lot, and begin a new lot.

The lot will be accepted with respect to gradation and asphalt content using statistical evaluation procedures in accordance with Subsection 401.19.

401.17 Acceptance Sampling & Testing of Asphalt Concrete Pavement Compaction. Take statistically random samples in accordance with the tests specified in Table 401-4. Take a minimum of five tests per lot. Acceptance or rejection of completed work will be on a lot basis. If the Contractor's quality control tests required in Table 401-4 are validated by the CO in accordance with Subsection 401.18 (Test Result Validation Procedure), then the Contractor's tests will be used for acceptance tests.

Use the nuclear gauge for acceptance. Calibrate the nuclear gauge in accordance with ASTM D 2950, Calibration section, within 6 months prior to use on this project, and check the standard and reference on each day of use in accordance with ASTM D 2950, Standardization and Reference Check sections. Do not take acceptance samples within 12 inches from the edges of the panel. Determine the LSL for compaction using either the control strip method or the maximum density method as follows:

(a) Control Strip Method. Use a control strip to establish the LSL. To determine the LSL, construct a control strip at the beginning of work on each type of material to be compacted. Leave each control strip, constructed to acceptable density and surface tolerances, in place to become a section of the completed roadway. Correct or remove unacceptable control strips and replace them at the Contractor's expense. Construct a control strip at least 300 feet long and one lane wide, and of the designated lift thickness SHOWN ON THE DRAWINGS.
Ensure that the materials used in the construction of the control strip meet the specification requirements. Furnish them from the same source and of the same type and asphalt content used in the remainder of the course represented by the control strip.

Use equipment in the construction of the control strip that meets the requirements of specified in Subsections 401.05 and 401.13, and that is of the same type and weight as that used on the remainder of the course represented by the control strip.
Begin compaction of the control strips immediately after the course has been placed to the specified thickness. Ensure that compaction is continuous and uniform over the entire surface. Continue compaction of the control strip until no discernible increase in density can be obtained by additional compactive effort.

Upon completion of the compaction, determine the mean density of the control strip by averaging the results of 10 consecutive nuclear density tests taken at randomly selected sites within the control strip. The mean density of the control strip must equal or exceed the density shown in Table 401-6.

Table 401-6. - Compaction requirements.

Road Grade (%)	**% of AASHTO T 209 Converted to density**
≤ 8	90
8 - 12	89
> 12	88

Cease paving if three consecutive control strips fail to achieve the specified minimum density. Take all necessary actions to resolve compaction problems. Do not resume paving without approval of the CO. The LSL shall then be 98 percent of the mean density of the control strip. Construct a new control strip if any of the following occur:

(1) A change in the properties of the material.

(2) A change in the rollers.

(3) A new layer.

(4) Changes in grade as indicated in Table 401-6.

(b) Maximum Density Method. The LSL shall be as shown in Table 401-6.

After the bituminous mixture has been placed and compacted, the lot will be accepted with respect to compaction using statistical evaluation procedures in accordance with Subsection 401.19. The maximum pay factor for compaction will be 1.00 for the control strip method and 1.05 for the maximum density method. If areas of isolated defect are identified by the CO, these areas will be treated as a separate lot.

401.18 Test Result Validation Procedure. Provide the CO with a duplicate of all required samples, specified in Table 401-4. If the Government decides to run assurance tests on the duplicate samples, the CO will determine the number to be run. Normally, the first three samples submitted will be tested, and 10 percent thereafter.

As testing is completed, the CO will evaluate all the Contractor testing. If Contractor testing is verified by Government testing, the Contractor's test results may be used by the Government to evaluate work for acceptance. If Contractor testing is not verified by Government testing, the Contractor has the option of either retesting or having the Government test the duplicate sample. The Contractor or the CO may witness the testing of the remaining sample portions. If the Contractor retests the sample, the test results will again be evaluated based on Government verification testing. If the test results are not valid, the Government test results will then be used for acceptance.

If it becomes necessary for the Government to test all of the samples for a work item due to the Contractor's tests being declared invalid, a payment deduction equal to the total cost of performing all of the testing for the applicable item will be made.

If the Contractor's test results are shown to be valid, but significant differences or shifts make the test results questionable, the CO will review the Contractor's equipment and test procedures.

If any deficiencies are identified that would account for the significant differences or shifts, the CO will suspend acceptance of all material until the deficiencies have been corrected. If no deficiencies that would account for the significant differences or shifts in test results can be identified, continue testing. In order to identify the deficiencies, the CO will increase testing frequency of sample portions.

401.19 Statistical Evaluation of Materials for Acceptance. Analyze all test results for a lot collectively and statistically by the *Quality Level Analysis — Standard Deviation Method*, using the procedures listed to determine the total estimated percent of the lot that is within specification limits. *Quality Level Analysis* is a statistical procedure for estimating the percent compliance to a specification. This procedure is affected by shifts in the arithmetic mean (X) and by the sample standard deviation(s). The analysis of each test parameter is based on an *Acceptable Quality Level* (AQL) of 95.0 and a producer's risk of 5 percent. The AQL may be viewed as the lowest percent of material inside the specification limit that is acceptable at the contract price. The producer's risk is the probability that when the Contractor is producing material at exactly the AQL, the material will receive less than a 1.00 pay factor. As an incentive to produce uniform quality material, payment of up to 5 percent more than the contract unit price may be obtained.

Quality Level Analysis—Standard Deviation Method Procedures are as follows:

(a) Determine the arithmetic mean (X) of each component tested:

$$X = \sum x / n$$

where

$\sum x$ = summation of individual test values

n = total number text value

(b) Compute the sample standard deviation(s):

$$s = \sqrt{\left(\frac{\sum x^2 - nX^2}{n-1} \right)}$$

where

$\sum x^2$ = summation of the squares of individual test values

X^2 = arithmetic mean squared

n = total number test values

(c) Compute the upper quality index (Q_u).

$$Q_u = \frac{USL - X}{s}$$

where

USL = TV plus allowable deviation

s = sample standard deviation

(d) Compute the lower quality index (Q_L):

$$Q_L = \frac{X - LSL}{s}$$

where

LSL = TV minus allowable deviation

s = sample standard deviation

(e) Determine P_u (the percent within the *USL* that corresponds to a given Q_u) from Table 401-7. Note that if a *USL* is not specified, P_u will be 100.

(f) Determine P_L (the percent within the *LSL* that corresponds to a given Q_L) from Table 401-7. Note that if an *LSL* is not specified, P_L will be 100.

(g) Determine the Quality Level (the total percent within specification limits) as follows:

$$\text{Quality Level} = (P_u + P_L) - 100$$

(h) Using the Quality Level from step (g), determine the pay factor (*PFi*) from Table 401-8 for each constituent tested.

The contract unit price will be paid for any lot for which at least three samples have been obtained and all of the test results meet the appropriate criteria listed below:

- All test results are within the allowable deviations specified for the item, or
- All test results are greater than or equal to a minimum specification limit, or
- All test results are less than or equal to a maximum specification limit.

Compute the Quality Level and composite pay factor (CPF) in these instances to determine the amount of any bonus that might be warranted.

If less than three samples have been obtained at the time a lot is terminated, include the material in this shortened lot as part of an adjacent lot at the pay factor computed for the revised lot.

If the lot does not meet the criteria for payment at the contract unit price, the lot will be accepted if the CPF is greater than 0.75, provided there are no isolated defects identified by the CO. If a lot contains a CPF less than 0.75, the lot will be rejected. The CO may permit one or more of the following:

- Require complete removal and replacement with specification material at no cost to the Government.

- At the Contractor's written request, allow corrective work at no additional cost to the Government, and then apply an appropriate price reduction that may range from no reduction to no payment.

- At the Contractor's written request, allow material to remain in place with an appropriate price reduction that may range from a designated percentage reduction to no payment.

Determine the CPF for each lot as follows:

$$\text{CPF} = \frac{\left[f1(PF1) + f2(PF2) + \ldots + fi(PFi)\right]}{\sum fi}$$

where

PFi = pay factor for each constituent tested

fi = weighting factor listed below for the applicable material:

Item	Weighting factor (*fi*)
½ inch and larger material	1
¼ to ½ inch material	3
1/8 to ¼ inch material	5
No. 200 to 1/8 inch material	3
No. 200 material	12
Asphalt content	29
Compaction	45

Measurement

401.20 Method. Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Calculate tonnage as the weight used in the accepted pavement. No deduction will be made for the weight of asphalt cement in the mixture.

Payment

401.21 Basis. The accepted quantities will be paid for at the contract unit price for each PAY ITEM listed below that is DESIGNATED IN THE SCHEDULE OF ITEMS, with the following exceptions:

(a) Payment for hot asphalt concrete pavement and asphalt cement will be made at a price determined by multiplying contract unit bid price by the CPF, as determined in Subsection 401.19.

(b) Payment for sampling and testing will be made as follows:

(1) Twenty-five percent of the lump sum, not to exceed 1/2 percent of the original contract amount, will be paid after all the testing facilities are in place, qualified sampling and testing personnel are identified, and the work being tested has started.

(2) Payment for the remaining portion of the lump sum will be prorated based on the total work completed.

(3) Payment for all or part of this PAY ITEM may be retained if the Government assurance tests invalidate the Contractor's testing.

Payment will be made under:

Pay Item		**Pay Unit**
401(01)	Hot asphalt concrete pavement, class ___, grading ___	Ton
401(02)	Superpave asphalt concrete pavement, nominal size ____	Ton
401(03)	State asphalt concrete pavement, class _____	Ton
401(04)	Hot asphalt concrete pavement, class _____, grading _____, wedge and leveling course	Ton
401(05)	Asphalt cement, grade _____	Ton
401(06)	Asphalt cement, State department of transportation grade _____	Ton
401(07)	Sampling and testing	Lump Sum

Table 401-7. - Quality Level Analysis by the Standard Deviation Method.

Estimated % Inside Specification Limits (P_u and or P_L)	Upper Quality Index (Q_u) or Lower Quality Index (Q_L)														
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10 to n=11	n=12 to n=14	n=15 to n=18	n=19 to n=25	n=26 to n=37	n=38 to n=69	n=70 to n=199	n=200 to n=999
100	1.16	1.05	1.79	2.03	2.23	2.39	2.35	2.65	2.83	3.03	3.20	3.38	3.54	3.70	3.83
99	-	1.47	1.67	1.80	1.89	1.95	2.00	2.04	2.09	2.14	2.18	2.22	2.26	2.29	2.31
98	1.15	1.44	1.60	1.70	1.76	1.81	1.84	1.86	1.91	1.93	1.96	1.99	2.01	2.03	2.05
97	-	1.41	1.54	1.62	1.67	1.70	1.72	1.74	1.77	1.79	1.81	1.83	1.85	1.86	1.87
96	1.14	1.38	1.49	1.55	1.59	1.61	1.63	1.65	1.67	1.68	1.70	1.71	1.73	1.74	1.75
95	-	1.35	1.44	1.49	1.52	1.54	1.55	1.56	1.58	1.59	1.61	1.62	1.63	1.63	1.64
94	1.13	1.32	1.39	1.43	1.46	1.47	1.48	1.49	1.50	1.51	1.52	1.53	1.54	1.55	1.55
93	-	1.29	1.35	1.38	1.40	1.41	1.42	1.43	1.44	1.44	1.45	1.46	1.46	1.47	1.47
92	1.12	1.26	1.31	1.33	1.35	1.36	1.36	1.37	1.37	1.38	1.39	1.39	1.40	1.40	1.40
91	1.11	1.23	1.27	1.29	1.30	1.30	1.31	1.31	1.32	1.32	1.33	1.33	1.33	1.34	1.34
90	1.10	1.20	1.23	1.24	1.25	1.25	1.26	1.26	1.26	1.27	1.27	1.27	1.28	1.28	1.28
89	1.09	1.17	1.19	1.20	1.20	1.21	1.21	1.21	1.21	1.22	1.22	1.22	1.22	1.22	1.23
88	1.07	1.14	1.15	1.16	1.16	1.16	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
87	1.06	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.13	1.13
86	1.04	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
84	1.01	1.02	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99
83	1.00	0.99	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95
82	0.97	0.96	0.95	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
81	0.96	0.93	0.91	0.90	0.90	0.89	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.88	0.88
80	0.93	0.90	0.88	0.87	0.86	0.86	0.86	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.84
79	0.91	0.87	0.85	0.84	0.83	0.82	0.82	0.82	0.82	0.81	0.81	0.81	0.81	0.81	0.81
78	0.89	0.84	0.82	0.80	0.80	0.79	0.79	0.79	0.78	0.78	0.78	0.78	0.78	0.78	0.78
77	0.87	0.81	0.78	0.77	0.76	0.76	0.76	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
76	0.84	0.78	0.75	0.74	0.73	0.73	0.72	0.72	0.72	0.71	0.71	0.71	0.71	0.71	0.71
75	0.82	0.75	0.72	0.71	0.70	0.70	0.69	0.69	0.69	0.68	0.68	0.68	0.68	0.68	0.68
74	0.79	0.76	0.69	0.68	0.67	0.66	0.66	0.66	0.66	0.65	0.65	0.65	0.65	0.64	0.64
73	0.76	0.69	0.66	0.65	0.64	0.63	0.63	0.63	0.62	0.62	0.62	0.62	0.62	0.61	0.61
72	0.74	0.66	0.63	0.62	0.61	0.60	0.60	0.60	0.59	0.59	0.59	0.59	0.59	0.58	0.58
71	0.71	0.63	0.60	0.59	0.58	0.57	0.57	0.57	0.57	0.56	0.56	0.56	0.56	0.55	0.55
70	0.68	0.60	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.53	0.53	0.53	0.53	0.53	0.52
69	0.65	0.57	0.54	0.53	0.52	0.52	0.51	0.51	0.51	0.50	0.50	0.50	0.50	0.50	0.50
68	0.62	0.54	0.51	0.50	0.49	0.49	0.48	0.48	0.48	0.48	0.47	0.47	0.47	0.47	0.47
67	0.59	0.51	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.45	0.44	0.44	0.44	0.44
66	0.56	0.48	0.45	0.44	0.44	0.43	0.43	0.43	0.42	0.42	0.42	0.42	0.41	0.41	0.41
65	0.52	0.45	0.43	0.41	0.41	0.40	0.40	0.40	0.40	0.39	0.39	0.39	0.39	0.39	0.39
64	0.49	0.42	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.36
63	0.46	0.39	0.37	0.36	0.35	0.35	0.35	0.34	0.34	0.34	0.34	0.34	0.33	0.33	0.33
62	0.43	0.36	0.34	0.33	0.35	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.31	0.31
61	0.39	0.33	0.31	0.30	0.32	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.28	0.28	0.28
60	0.36	0.30	0.28	0.27	0.30	0.27	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.25
59	0.32	0.27	0.25	0.25	0.24	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.23
58	0.29	0.24	0.23	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.20	0.20	0.20	0.20
57	0.25	0.21	0.20	0.19	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.18	0.18	0.18
56	0.22	0.18	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.15	0.15	0.15
55	0.18	0.15	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
54	0.14	0.12	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
53	0.11	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
52	0.07	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
51	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: If value of Q_u or Q_L does not correspond to a value in the table, use the next lower value. If Q_u or Q_L are negative values, P_u or P_L is equal to 100 minus the table value for P_u or P_L .
If the value of Q_u or Q_L does not correspond exactly to a figure in the table, use the next higher figure.

Table 401-8. - Required quality level for a given sample size (*n*) and a given pay factor (*Pfi*).

PFi	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10 to n=11	n=12 to n=14	n=15 to n=18	n=19 to n=25	n=26 to n=37	n=38 to n=69	n=70 to n=199	n=200 to n=999
1.05	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.04	90	91	92	93	93	93	94	94	95	95	96	96	97	97	99
1.03	80	85	87	88	89	90	91	91	92	93	93	94	95	96	97
1.02	75	80	83	85	86	87	88	80	89	90	91	92	93	94	95
1.01	71	77	80	82	84	85	85	86	87	88	89	90	91	93	94
1.00	68	74	78	80	81	82	83	84	85	86	87	89	90	91	93
0.99	66	72	75	77	79	80	81	82	83	85	86	87	88	90	92
0.98	64	70	73	75	77	78	79	80	81	83	84	85	87	88	90
0.97	62	68	71	74	75	77	78	78	80	81	83	84	85	87	89
0.96	60	66	69	72	73	75	76	77	78	80	81	83	84	86	88
0.95	59	64	68	70	72	73	74	75	77	78	80	81	83	85	87
0.94	57	63	66	68	70	72	73	74	75	77	78	80	81	83	86
0.93	56	61	65	67	69	70	71	72	74	75	77	78	80	82	84
0.92	55	60	63	65	67	69	70	71	72	74	75	77	79	81	83
0.91	53	58	62	64	66	67	68	69	71	73	74	76	78	80	82
0.90	52	57	60	63	64	66	67	68	70	71	73	75	76	79	81
0.89	51	55	59	61	63	64	66	67	68	70	72	73	75	77	80
0.88	50	54	57	60	62	63	64	65	67	69	70	72	74	76	79
0.87	48	53	56	58	60	62	63	64	66	67	69	71	73	75	78
0.86	47	51	55	57	59	60	62	63	64	66	68	70	72	74	77
0.85	46	50	53	56	58	59	60	61	63	65	67	69	71	73	76
0.84	45	49	52	55	56	58	59	60	62	64	65	67	69	72	75
0.83	44	48	51	53	55	57	58	59	61	63	64	66	68	71	74
0.82	42	46	50	52	54	55	57	58	60	61	63	65	67	70	72
0.81	41	45	48	51	53	54	56	57	58	60	62	64	66	69	71
0.80	40	44	47	50	52	53	54	55	57	59	61	63	65	67	70
0.79	38	43	46	48	50	52	53	54	56	58	60	62	64	66	69
0.78	37	41	45	47	49	51	52	53	55	57	59	61	63	65	68
0.77	36	40	43	46	48	50	51	52	54	56	57	60	62	64	67
0.76	34	39	42	45	47	48	50	51	53	55	56	58	61	63	66
0.75[a]	33	38	41	44	46	47	49	50	51	53	55	57	59	62	65

Note: if the computed Quality Level does not correspond exactly to a figure in the table, use the next lower value.
[a] Reject quality levels less than those specified for a 0.75 pay factor.

Section 402 - Major Hot Asphalt Concrete Pavement

Description

402.01 Work. Construct one or more courses of hot asphalt concrete pavement as SHOWN ON THE DRAWINGS. Have the surface approved by the CO in writing before placing the hot asphalt concrete pavement.

Hot asphalt concrete pavement classes are designated as shown in Table 402-1. Hot asphalt concrete pavement aggregate grading is designated as shown in Table 703-4. State asphalt concrete pavement classes are designated by local State department of transportation designations.

Asphalt cement grade is designated as shown in AASHTO M 20, M 226, or MP 1, or in applicable State department of transportation specifications for asphalt materials for the grade specified.

A prepaving conference will be held at least 10 working days prior to the beginning of paving operations. At that time, the Contractor and the CO will discuss methods of accomplishing all phases of the paving work, including laydown operations, work schedules, work force, quality control systems, spill prevention and contingency plans, and asphalt concrete mix delivery.

Materials

402.02 Requirements. Ensure that material conforms to the requirements specified in the following subsections:

Antistrip Additive	702.07
Asphalt Cement	702.01
Hot Asphalt Concrete Pavement Aggregate	703.07
Mineral Filler	725.05
Recycling Agent	702.05

Ensure that reclaimed asphalt pavement material conforms to the following:

(a) 100 percent passes the 2-inch screen.

(b) The material consists of asphalt cement and asphalt cement-coated aggregate.

Construction

402.03 Composition of Mixture (Job-Mix Formula). Up to 20 percent reclaimed asphalt pavement material may be used, subject to approval of a Contractor quality control plan and submission of test data demonstrating that the mixture will meet the requirements specified in this section.

Table 402-1- Asphalt concrete mixture requirements.

Design Parameters[a]	Class of Mixture A	B	C
(a) Hveem (AASHTO T 246 and T 247):			
(1) Stabilometer, min.	37	35	30
(2) Air voids, %[a]	3 - 5	3 - 5	3 - 5
(3) Voids in Mineral Aggregate (VMA) min %	See Table 402-2		
(b) Marshall (AASHTO T 245):[b]			
(1) Stability, lbs min.	1,800	1,200	1,000
(2) Flow, 0.01 in	8 - 14	8 - 16	8 - 20
(3) Air voids, %[a]	3-5	3-5	3-5
(4) Voids in Mineral Aggregate, min %	See Table 403-2		
(5) Compaction, number of blows each end of test specimen	75	50	50
(c) Immersion-Compression (AASHTO T 165 and T 167):			
(1) Compressive strength, min. psi	300	250	200
(2) Retained strength, min %	70	70	70
(d) Root-Tunnicliff (AASHTO D 4867):			
(1) Tensile strength ratio, min %	70	70	70
(e) Dust/asphalt ratio[c]	0.6 - 1.3	0.6 - 1.3	0.6 - 1.3

[a] The percent of air voids is based on AASHTO T 166, AASHTO T 209, and AASHTO T 269. Maximum specific gravity will be based on AASHTO T 209.
[b] Following mixing, asphalt cement mixtures will be cured in an oven maintained at 55 °F to 65 °F above the compaction temperature for 90 $\pm$ 10 minutes.
[c] Dust/asphalt ration is defined as the percent of material, including nonliquid antistrip and mineral filler, that passes the No. 200 sieve, divided by the percent of asphalt (calculated by mass of mix).

Furnish the appropriate mixture as follows:

(a) Hot Asphalt Concrete Pavement Mixture. Furnish aggregate, asphalt additives, and, when applicable, reclaimed asphalt pavement material that meet the applicable aggregate gradation requirement shown in Table 703-4, and design parameters (a) or (b); (c) or (d); and (e) shown in Table 402-1.

(b) State Asphalt Concrete Pavement Mixture. Furnish aggregate, asphalt, and additives that meet applicable aggregate gradation and aggregate quality requirements of the local State department of transportation, and design parameters (a) or (b); (c) or (d); and (e) shown in Table 402-1. Local State department of transportation design parameters in lieu of those in Table 402-1 may be used if approved by the CO.

Submit written job-mix formulas for approval at least 21 days before production. For each job-mix formula, submit the following:

Table 402-2. – VMA for Marshall, Hveem, mix design.

Sieve Size[a] (inch)	Minimum Voids [(b)(c)] Percent	
	Marshall	Hveem
No. 8	21	19
No. 4	18	16
3/8	16	14
½	15	13
¾	14	12
1	13	11
1 1/2	12	10
2	11.5	9.5

[a] The largest sieve size listed in the applicable specifications upon which any material is permitted to be retained.
[b] VMA to be determined in accordance with Asphalt Institute (AI) Manual Series number 2 (MS-2).
[c] When a mineral filler or nonliquid antistrip is use, include the percentage specified in the calculation for compliance with the VMA.

(1) Aggregate and mineral filler, including:

(a) TV for percent passing each sieve size for the aggregate blend. Ensure that the gradation of the blended aggregate and reclaimed asphalt pavement falls within the gradation band for each sieve size designated in the specified grading.

(b) Source and percentage of each aggregate stockpile to be used.

(c) Average gradation of each aggregate stockpile.

(d) Results of aggregate quality tests.

(e) Samples, when SHOWN ON THE DRAWINGS.

(2) Asphalt cement, including:

(a) TV for percent of asphalt cement based on total weight of mix.

(b) Recent quality test results from the manufacturer for the asphalt cement, including a temperature-viscosity curve.

(c) Material safety data sheets.

(d) Samples, when SHOWN ON THE DRAWINGS.

(3) Antistrip additives. When applicable, furnish:

(a) Type and TV for percent of antistrip additive.

(b) Material safety data sheet.

(c) Samples, when SHOWN ON THE DRAWINGS.

(4) Mix temperatures, including:

(a) Temperatures leaving the mixer.

(b) Temperature immediately preceding initial compaction.

(5) Maximum specific gravity, determined according to AASHTO T 209 at the asphalt cement TV.

(6) Reclaimed asphalt pavement material; when applicable, the percent reclaimed asphalt pavement material and type and percent of recycling agent.

(7) Asphalt mixtures; when applicable, the location of all commercial mixing plants to be used. A job-mix formula is needed for each plant.

The CO will evaluate the suitability of the material and the proposed job-mix formula. After reviewing the proposed job-mix formula, the CO will develop a TV for the asphalt cement content and determine the need for antistrip additive, the specific gravity in accordance with AASHTO T 209, and the discharge temperature range.

If a job-mix formula is rejected, submit a new job-mix formula as described above.

Changes to an approved job-mix formula require approval before production. Allow up to 14 days to evaluate a change. Approved changes in TV's will not be applied retroactively for payment.

402.04 Mixing Plant. Use mixing plants that conform to ASTM D 995, unless producing approved materials for a local State department of transportation. Supplement mixing plant as follows:

(***a) All Plants***. For all plants, use:

(1) Automated Controls. Automatically control the proportioning, mixing, and discharging of the mixture.

(2) Emission Controls. If a wet scrubber is used, circulate the collected material through sludge pits or settling tanks. Remove the resultant sediment from the project or bury according to Subsection 202.04.

(b) Drum Dryer-Mixer Plants. For drum dryer-mixer plants, use:

(1) Bins. Provide a separate bin in the cold aggregate feeder for each individual aggregate stockpile in the mixture. Use bins of sufficient size to keep the plant in continuous operation, and of proper design to prevent overflow of material from one bin to another.

(2) Stockpiling Procedures. Separate aggregate into at least two stockpiles with different gradations. As a minimum, one stockpile shall contain mostly coarse material, and one stockpile shall contain mostly fine material.

(3) Reclaimed Asphalt Pavement Material. Modify drum dryer-mixer plants to prevent direct contact of the reclaimed asphalt pavement material with the burner flame and to prevent overheating of the reclaimed asphalt pavement material.

(c) Batch & Continuous Mix Plants. For batch and continuous mix plants, use:

(1) A Hot Aggregate Bin. Provide a bin with three or more separate compartments for storage of the screened aggregate fractions to be combined for the mixture. Make the partitions between the compartments tight and of sufficient height to prevent spillage of aggregate from one compartment into another.

(2) Load Cells. Calibrated load cells instead of scales may be used in batch plants.

(3) Reclaimed Asphalt Pavement Material. Modify batch plants to allow the introduction of reclaimed asphalt pavement material into the mixture using methods that bypass the dryer. Design the cold feed bin, conveyor system, and special bin adjacent to the weigh hopper, if used, to avoid segregation and sticking of the reclaimed asphalt pavement material. Heat the new aggregate and/or reclaimed aggregate material to a temperature that will transfer sufficient heat to the reclaimed asphalt pavement material to produce a mix of uniform temperature within the range specified in the approved job-mix formula.

402.05 Pavers. Use pavers that are:

(a) Self-contained, power-propelled units with adjustable vibratory screeds with full-width screw augers.

(b) Heated for the full width of the screed.

(c) Capable of spreading and finishing courses of asphalt mixture in widths at least 12 inches more than the width of one lane.

(d) Equipped with a receiving hopper with sufficient capacity to ensure a uniform spreading operation.

(e) Equipped with automatic feed controls that are properly adjusted to maintain a uniform depth of material ahead of the screed.

(f) Capable of being operated at forward speeds consistent with satisfactory laying of the mixture.

(g) Capable of producing a finished surface of the required smoothness and texture without segregating, tearing, shoving, or gouging the mixture.

(h) Equipped with automatic screed controls with sensors capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals that operate the screed to maintain grade and transverse slope.

402.06 Surface Preparation. Prepare the surface in accordance with Section 304, 306, 307, or 308, as applicable. Apply an asphalt tack coat to contact surfaces of curbing, gutters, manholes, and other structures in accordance with Section 407.

402.07 Weather Limitations. Place hot asphalt concrete pavement on a dry, unfrozen surface when the air temperature in the shade is above 35 °F and rising, and the temperature of the road surface in the shade, the lift thickness, and the minimum lay down temperature are as shown in Table 402-3.

402.08 Asphalt Preparation. Uniformly heat the asphalt cement to provide a continuous supply of the heated asphalt cement from storage to the mixer. Do not heat asphalt cement above 350 °F.

Table 402-3. - Minimum laydown temperature[a] for hot asphalt concrete mixture placement (^{o}F)

Lift Thickness (inches)	**< 2**	**2 – 3**	**> 3**
Road Surface Temperature (^{o}F)	**Minimum Lay-Down Temperatures (^{o}F)**		
<35	-[b]	-[b]	-[b]
35 – 39.9	-[b]	-[b]	280
40 – 49.9	-[b]	285	275
50 – 59.9	295	280	270
60 – 69.9	285	275	265
70 – 79.9	280	270	265
80 – 89.9	270	265	260
≥ 90	265	260	255

[a] Never heat the asphalt concrete mixture above the temperature specified in the approved mix design.
[b] Paving not allowed.

If the job-mix formula requires a liquid heat-stable antistrip additive, meter it into the asphalt cement transfer lines at a bulk terminal or mixing plant. Inject the additive for at least 80 percent of the transfer or mixing time to obtain uniformity.

402.09 Aggregate Preparation. If nonliquid antistrip is used, adjust the aggregate moisture to at least 4 percent by weight of aggregate. Mix the antistrip uniformly with the aggregate before introducing the aggregate into the dryer or dryer drum. Use calibrated weighing or metering devices to measure the amount of antistrip and moisture added to the aggregate.

For batch plants, heat, dry, and deliver aggregate for pugmill mixing at a temperature sufficient to produce a mixture temperature within the approved range. Adjust flames used for drying and heating to prevent damage to, and contamination of, the aggregate.

Control plant operations so the moisture content of the mixture behind the paver is 1/2 percent or less, in accordance with AASHTO T 110.

402.10 Mixing. Measure the aggregate and asphalt into the mixer in accordance with the approved job-mix formula. Mix until all the particles are completely and uniformly coated with asphalt in accordance with ASTM D 995. Maintain the discharge temperature within the approved range.

402.11 Hauling. Use vehicles with tight, clean, smooth metal beds for hauling asphalt concrete mixtures.

Thinly coat the beds with an approved material to prevent the mixture from adhering to the beds. Do not use petroleum derivatives or other coating material that contaminates or alters the characteristics of the mixture. Drain the bed before loading.

Equip each truck with a canvas cover or other suitable material of sufficient size to protect the mixture from the weather. When necessary to maintain temperature, use insulated truck beds and securely fastened covers. Provide access ports or holes for checking the temperature of the asphalt mixture in the truck.

402.12 Placing & Finishing. Do not use mixtures produced from different plants unless the mixtures are produced in accordance with the same job-mix formula, use material from the same sources, and are approved.

Place asphalt concrete mixture at a temperature that conforms to Table 402-3. Measure temperature of the mixture in the hauling vehicle just before dumping into spreader, or measure it in the windrow immediately before pickup.

Place the mixture with a paver that conforms to specifications in Subsection 402.05. Control horizontal alignment using a reference line. Automatically control the grade and slope from reference lines, a ski and slope control device, dual skis. Use skis with a minimum length of 20 feet.

Limit the compacted thickness to 3 inches, unless otherwise SHOWN ON THE DRAWINGS.

On areas where mechanical spreading and finishing is impractical, place and finish the mixture with alternate equipment to produce a uniform surface closely matching the surface obtained when using a mechanical paver.

Offset the longitudinal joint of one layer at least 6 inches from the joint in the layer immediately below. Make the longitudinal joint in the top layer along the centerline of two-lane roadways or at the lane lines of roadways with more than two lanes. Offset transverse joint in adjacent lanes and in multiple lifts at least 10 feet.

The CO will designate the job-mix formula to be used for wedge and leveling courses at each location unless DESIGNATED IN THE SCHEDULE OF ITEMS. Place wedge and leveling courses in maximum 3 inch lifts and compact with a pneumatic-tire roller meeting the requirements of Subsection 203.15(d). Complete the wedge and leveling before starting normal paving operations.

402.13 Compacting. Furnish at least three rollers, one each for breakdown, intermediate, and finish rolling. Furnish at least one roller with pneumatic tires. Size the rollers to achieve the required results. Operate rollers in accordance with manufacturer's recommendations.

Thoroughly and uniformly compact the asphalt surface by rolling. Do not cause undue displacement, cracking, or shoving. Continue rolling until all roller marks are eliminated and the required compaction is obtained. Do not vibratory roll the mixture after its surface cools below 175 °F.

Along forms, curbs, headers, walls, and other places not accessible to the rollers, use other equipment to obtain the minimum compaction of the mixture.

402.14 Joints, Trimming Edges, & Cleanup. At connections to existing pavements and previously placed lifts, make the transverse joints vertical to the depth of the new pavement. Form transverse joints by cutting back on the previous run to expose the full depth course. Dispose of trimmed asphalt material in accordance with Subsection 210.02(a).

Apply an asphalt tack coat to the edge of the joint for both transverse and longitudinal joints, and where SHOWN ON THE DRAWINGS, in accordance with Section 407.

Place the asphalt concrete mixture as continuously as possible. Do not pass rollers over the unprotected end of a freshly laid mixture.

402.15 Acceptance. Provide a quality control plan, and then sample, test, and maintain records according to Section 160. See Table 402-4 for minimum sampling and testing requirements. Sample to ensure that:

(a) The sample size is adequate to provide a duplicate to the CO and to meet potential need for retesting as specified in Subsection 402.18.

(b) Samples are prepared according to AASHTO T 248 or other procedures applicable to the item being sampled.

(c) The sample is adequately identified and placed in CO-approved containers provided by the Contractor.

The CO may perform quality assurances testing, and these tests will be made available to the Contractor upon request.

A lot is defined as the number of tons of material or work produced, and/or placed under one set of TV's. The lot will be represented by randomly selected samples tested for acceptance. Plant and equipment operators will not be advised ahead of time when samples are taken.

Acceptance will be evaluated as follows:

(a) Asphalt Cement. Asphalt cement will be evaluated for acceptance under Subsection 106.05.

(b) Pavement Smoothness. Use a 10 foot metal straightedge to measure at right angles and parallel to the centerline at designated sites. Surface deviations in excess of 3/8 inch between any two contacts of the straightedge with the surface are defective areas. Correct these areas using approved methods.

(c) Thickness & Width. Ensure that the thickness and width of the compacted mixture conform to the dimensions SHOWN ON THE DRAWINGS and meet the following requirements:

(1) The maximum variation from the specified thickness is less than 1/4 inch for the wearing course or ½ inch for the base course.

(2) The compacted width has a (+) 6 inch tolerance.

(3) The compacted thickness and width are not consistently above or below the specified dimension.

(d) Asphalt Concrete Mixture Gradation and Asphalt Content. Gradation and asphalt content will be evaluated for acceptance under Subsection 402.16.

(e) Asphalt Concrete Pavement Compaction. Compaction will be evaluated for acceptance under Subsection 402.17.

402.16 Acceptance Sampling & Testing of Asphalt Concrete Mixture Gradation & Asphalt Content. Take statistically random samples in accordance with the tests specified in Table 402-4. Take a minimum of three tests per lot. Acceptance or rejection of completed work will be on a lot basis. If the Contractor quality control tests required in Table 402-4 are validated by the CO in accordance with Subsection 402.18 (Test Result Validation Procedure), then the Contractor tests shall be used for acceptance tests. Take samples of the mixture at the plant in approved State department of transportation sampling devices, or after the mixture has been discharged into hauling units or placed on the road in accordance with AASHTO T 168. Test the samples for asphalt content by means of AASHTO T 164, method B (Reflux Method) or method E (Vacuum Extraction). Other methods, including nuclear, require approval in writing by the CO, and may require an increased sampling and testing frequency. Report the asphalt content to the nearest 0.01 percent. Determine gradation of the entire quantity of extracted material in accordance with AASHTO T 30, but report results to the nearest 0.1 percent for all

sieves except the No. 200 sieve; report this sieve to the nearest 0.01 percent. Determine the percent moisture in the asphalt concrete mixture in accordance with AASHTO T 110.

If samples are tested for asphalt content by means of AASHTO T 164, determine an Extraction Retention Factor based on the average difference between at least three samples of known asphalt content and corresponding asphalt content by the same procedure that will be used for acceptance. Prepare the samples in accordance with Table 402-1, (b) Marshall, unless otherwise approved by the CO.

Table 402-4. - Sampling and testing.

Type of acceptance	Material or Product	Property or Characteristic	Test Method or Specification	Frequency	Sampling Point
Production certification (subsection 105.04)	Asphalt cement	Contract requirements	AASHTO M 20, M 226, or MP 1, as applicable	Daily	-
Tested conformance	Material source	Los Angeles abrasion	AASHTO T 96	Three times for each undeveloped source, [b] or once for all other sources	Material source
		Sodium sulfate soundness loss	AASHTO T 104		
		Durability index (course and fine)	AASHTO T 210		
	Aggregate	Fractured faces (course)[a]	FLH T 507		Cold feed prior to entering dryer
		Sand equivalent Value (fine)	AASHTO T 176 Alternate method Number 2 (referee method)		
	Asphalt cement	Sample	Subsection 105.04(b)	Once for each 500 tons of mix, and not more than three times per day	At point of shipment delivery
	Job-mix formula	Contract requirements	Subsection 402.03	Once for each product or material change	-
Mix evaluation	Hot asphalt concrete pavement	Asphalt content	AASHTO T 164 Method B or E	Once for each 500 tons, not more than three times per day	At plant, in hauling units, or behind laydown machine before rolling
		Gradation	AASHTO T 30		
		Compaction	ASTM D 2950, "Procedure"	Five times for each 500 ton, and not less than five times per day	In-place after compaction
		Maximum specific gravity	AASHTO T 209	Once for each 1,000 ton	At plant, in hauling units, or behind laydown machine before rolling

[a] Use only for gravel sources.
[b] An undeveloped source is a source that has not supplied aggregate for asphalt concrete within 365 days of the start of producing asphalt concrete for this particular project.

If areas of isolated defect are identified by the CO, treat these areas as a separate lot.

The Contractor may request a change in TV's subject to the provisions in Subsection 402.03. If the TV's are changed, evaluate all of the material produced up to the time of the change as a lot, and begin a new lot.

The lot will be accepted with respect to gradation and asphalt if the average of all test results fall within the tolerances shown in Table 402-5.

402.17 Acceptance Sampling & Testing of Asphalt Concrete Pavement Compaction. Take statistically random samples in accordance with the tests specified in Table 402-4. Take a minimum of five tests per lot. Acceptance or rejection of completed work will be on a lot basis. If the Contractor's quality control tests required in Table 402-4 are validated by the CO in accordance with Subsection402.18 (Test Result Validation Procedure), then the Contractor's tests will be used for acceptance tests.

Table 402-5. - Mix tolerances.

Mixture Characteristic	Tolerances
Bitumen Content	TV ± 0.5
Sieve size:	
No. 4 and larger	TV ± 6.0
No. 30 to No. 4	TV ± 4.0
No. 50 to No. 30	TV ± 3.0
No. 200 to No. 50	TV ± 2.0
Temperature:	
Leaving the mixture	TV + 10 ^{o}F
Placed on the road	TV + 15 ^{o}F

Use the nuclear gauge for acceptance. Calibrate the nuclear gauge in accordance with ASTM D 2950, Calibration section, within 6 months prior to use on this project, and check the standard and reference on each day of use in accordance with ASTM D 2950, Standardization and Reference Check sections. Do not take acceptance samples within 12 inches from the edges of the panel. Determine the TV for compaction using either the Control Strip Method or the Maximum Density Method as follows:

Table 402-6. - Compaction requirements.

Road Grade (%)	% of AASHTO T 208 Converted to density
≤ 8	90
8 - 12	89
> 12	88

(a) Control Strip Method. Construct a control strip at the beginning of work on each type of material to be compacted. Construct each control strip to acceptable density and

surface tolerances, and leave it in place to become a section of the completed roadway. Correct or remove unacceptable control strips, and replace them at the Contractor's expense. Construct a control strip at least 300 feet long and one lane wide, and at the compacted lift thickness SHOWN ON THE DRAWINGS.

Ensure that the materials used in the construction of the control strip meet the specification requirements. Furnish them from the same source and of the same type and asphalt content used in the remainder of the course represented by the control strip.

Use equipment in the construction of the control strip that meets the requirements specified in Subsections 402.05 and 402.13, and is of the same type and weight as that to be used on the remainder of the course represented by the control strip.

Begin compacting the control strips immediately after the course has been placed to the specified thickness. Ensure that compaction is continuous and uniform over the entire surface. Continue compaction of the control strip until no discernible increase in density can be obtained by additional compactive effort.

Upon completion of the compaction, determine the mean density of the control strip by averaging the results of 10 consecutive nuclear density tests taken at randomly selected sites within the control strip. The mean density of the control strip must equal or exceed the density shown in Table 402-6. The TV shall then be 98 percent of the mean density of the control strip.

Cease paving if three consecutive control strips fail to achieve the specified minimum density. Take all necessary actions to resolve compaction problems. Do not resume paving without approval by the CO. Construct a new control strip in case of any of the following:

(1) Any change in the properties of the material.

(2) Any change in the rollers.

(3) A new layer.

(4) Or changes in grade as indicated in Table 402-6.

(b) Maximum Density Method. The TV shall be as shown in Table 402-6. After the bituminous mixture has been placed and compacted, compaction for the lot will be accepted if both of the following apply:

(1) All individual test results equal or exceed 98 percent of the TV.

(2) The average of all tests equals or exceeds the TV.

402.18 Test Result Validation Procedure. Provide the CO with a duplicate of all samples specified in Table 402-4. If the Government decides to run assurance tests on the

duplicate samples, the CO will determine the number to be run. Normally, the first three samples submitted will be tested, and 10 percent thereafter.

As testing is completed, the CO will evaluate all the Contractor testing. If Contractor testing is verified by Government testing, the Contractor's test results may be used by the Government to evaluate work for acceptance. If Contractor testing is not verified by Government testing, the Contractor has the option of either retesting or having the Government test the duplicate sample. The Contractor or the CO may witness the testing of the remaining sample portions. If the Contractor retests the sample, the test results will again be evaluated based on Government verification testing. If the test results are not valid, the Government test results will then be used for acceptance.

If it becomes necessary for the Government to test all of the samples for a work item due to the Contractor's tests being declared invalid, a payment deduction equal to the total cost of performing all of the testing for the applicable item will be made.

If the Contractor's test results are shown to be valid, but significant differences or shifts make the test results questionable, the CO will review the Contractor's equipment and test procedures.

If any deficiencies are identified that would account for the significant differences or shifts, the CO will suspend acceptance of all material until the deficiencies have been corrected. If no deficiencies that would account for the significant differences or shifts in test results can be identified, continue testing. In order to identify the deficiencies, the CO will increase testing frequency of sample portions.

Measurement

402.19 Method. Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Calculate the tonnage as the weight used in the accepted pavement, and make no deduction for the weight of asphalt cement in the mixture.

Payment

402.20 Basis. The accepted quantities will be paid at the contract unit price for each PAY ITEM listed below that is DESIGNATED IN THE SCHEDULE OF ITEMS, except that payment for sampling and testing will be made as follows:

(a) Twenty-five percent of the lump sum, not to exceed ½ percent of the original contract amount, will be paid after all the testing facilities are in place, qualified sampling and testing personnel are identified, and the work being tested has started.

(b) Payment for the remaining portion of the lump sum will be prorated based on the total work completed.

(c) Payment for all or part of this PAY ITEM may be retained if the Government assurance tests invalidate the Contractor's testing.

Payment will be made under:

Pay Item		**Pay Unit**
402(01)	Hot asphalt concrete pavement, class _____, grading _____	Ton
402(02)	State asphalt concrete pavement, class _____	Ton
402(03)	Hot asphalt concrete pavement, class _____, grading _____, wedge, and level course	Ton
402(04)	Asphalt cement, grade _____	Ton
402(05)	Asphalt cement, State department of transportation grade _____	Ton
402(06)	Sampling and testing	Lump Sum

Section 403 - Minor Hot Asphalt Concrete Pavement

Description

403.01 Work. Construct one or more courses of hot asphalt concrete plant mix on a prepared surface as SHOWN ON THE DRAWINGS. Have the surface approved by the CO in writing prior to placing hot asphalt concrete plant mix.

Materials

403.02 Asphalt Cement. Ensure that asphalt cement meets the requirements specified in Subsection 702.01. The exact percent of asphalt cement and the grade to be used will be furnished by the CO after requirements in Subsection 403.05 have been reviewed and evaluated. Ensure that mixing temperatures meet the requirements specified in Subsection 702.04.

403.03 Aggregate. Ensure that aggregate meets the requirements specified in Subsection 703.07, except for aggregate gradation. Maximum gradation size or suggested gradation designations will be SHOWN ON THE DRAWINGS.

403.04 Additives. Additives, such as filler, hydrated lime, and antistrip agents, may be used as necessary to meet specifications. Ensure that filler meets the requirements of AASHTO M 17, hydrated lime meets the requirements of AASHTO M 216, Type N, and antistrip materials meet the requirements specified in Subsection 702.07.

403.05 Job-Mix Formula. Submit a job-mix formula and supporting documentation, test results, and calculations for the material to be incorporated into the work. Include copies of laboratory test results and mix design data that demonstrate that the properties of the aggregate, additives, and mixture meet those requirements and criteria of local public agencies or the AI. After reviewing the Contractor's proposed job-mix formula, the CO will determine the final values for the job-mix formula to be used and notify the Contractor in writing.

Construction

403.06 Asphalt Mixing Plant. Ensure that plants used for preparing hot asphalt concrete mixtures are manufactured for that purpose, in good repair, and capable of mixing the material to a uniform consistency.

403.07 Hauling Equipment. Ensure that trucks used for hauling asphalt concrete mixtures have tight, clean, smooth metal beds that have been thinly coated with a material to prevent the mixture from adhering to the beds. Do not use petroleum derivatives or other coating material that contaminates or alters the characteristics of the mixture. Drain truck beds prior to loading, and ensure that each truck has a cover to protect the mixture from weather. When necessary to ensure that the mixture will be delivered at the specified temperature, ensure that truck beds are insulated and covers securely fastened.

403.08 Pavers. Use pavers that are in good working order and have an adjustable vibrating screed or strike-off assembly, heated if necessary, and an auger ahead of the screed to distribute the mixture. Use pavers that are capable of spreading and finishing courses of asphalt concrete plant mix material in lane widths and thickness SHOWN ON THE DRAWINGS. Unless otherwise SHOWN ON THE DRAWINGS, towed-type pavers and Layton-type pavers or graders may be used to place and spread the asphalt concrete plant mix material.

403.09 Rollers. Ensure that all rollers meet the requirements specified in Subsections 203.15(b), (c), and (d). Where it is impractical to operate larger rollers, 3- to 5-ton rollers may be used. On walkways, 1-ton rollers may be used.

403.10 Weather Limitations. Do not place the asphalt concrete mixture when weather conditions prevent the proper compaction of the mixture, the base course is frozen, or the average temperature of the underlying surface upon which the asphalt concrete mixture is to be placed is less than 45 °F, or when it is raining or snowing.

403.11 Conditioning of Existing Surface. Immediately before placing the asphalt concrete mixture, clean the existing surface of loose or deleterious material.

Before placing the asphalt concrete mixture, paint the contact surfaces of curbing, gutters, manholes, and other structures with a thin, uniform coating of asphalt material.

403.12 Control of Asphalt Concrete Mixture. Supply a certification from the mixing plant stating that the mix conforms to the approved job-mix formula. The CO may reject any batch, load, or section of roadway that appears defective in gradation, asphalt cement content, or moisture content. Do not incorporate material rejected before placement into the pavement. Remove any rejected section of roadway. No payment will be made for the rejected materials or the removal of the materials, unless the Contractor requests that the rejected material be tested, at the Contractor's expense, under the following provisions:

(a) Obtain three representative samples and have them tested at a laboratory approved by the CO.

(b) If test results show that the material conforms to the tolerance shown in Table 403-1, payment will be made for the material, and for its removal and testing.

403.13 Transporting, Spreading, & Finishing. Transport the mixture from the mixing plant to the point of use in vehicles that meet the requirements specified in Subsection 403.07.

Spread the mixture and strike it off to the grade and elevation established. Provide a maximum compacted lift thickness of 4 inches unless otherwise SHOWN ON THE DRAWINGS.

Table 403-1. – Allowable tolerances.

Mixture Characteristic	Tolerances
Asphalt Content	Job-mix formula ±0.5
Sieve size:	
3/8 and larger	Job-mix formula ±5.0
No. 4 to 3/8	Job-mix formula ±7.0
No. 200 to No. 4	Job-mix formula ±5.0
No. 200	Job-mix formula ±2.0

Ensure that the longitudinal joint in any layer offsets that in the layer immediately below by approximately 6 inches. Where laydown requires placement of two adjacent panels to cover the surface of a traveled way, ensure that the longitudinal joint of the top layer is at the centerline. This requirement does not apply to turnouts, extra widening, or parking areas. Offset transverse joints in succeeding layers and in adjacent lanes at least 10 feet, where possible.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture may be placed and finished using hand tools.

403.14 Compaction. Thoroughly and uniformly compact the surface with rollers that meet the requirements specified in Subsection 403.09, and perform initial compaction while the mixture is above 250 °F. Perform finish rolling with steelwheel rollers and continue until no roller tracks remain.

Measurement

403.15 Method. Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Calculate the quantity of hot asphalt concrete mix that is the tonnage of combined aggregate and asphalt cement used in the accepted work. No separate payment will be made for asphalt cement used in the mixture.

Payment

403.16 Basis. The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

Pay Item		Pay Unit
403(01)	Hot asphalt concrete plant mix	Ton
403(02)	Hot asphalt concrete plant mix	Square Yard

Section 404 - Major Cold Asphalt Concrete Pavement

Description

404.01 Work. Construct one or more courses of cold asphalt concrete pavement on a prepared surface that has been approved in writing by the CO.

Cold asphalt concrete pavement grade is designated as shown in Table 703-5 or Table 703-6.

Cutback asphalt grade is designated as shown in AASHTO M 81, AASHTO M 82, or ASTM D 2026. Emulsified asphalt grade is designated as shown in AASHTO M 140 or M 208.

A prepaving conference will be held at least 10 working days prior to the beginning of paving operations. At that time, the Contractor and the CO will discuss methods of accomplishing all phases of the paving work, including laydown operations, work schedules, work force, quality control systems, spill prevention and contingency plans, and asphalt concrete mix delivery.

Materials

404.02 Requirements. Ensure that the material conforms to specifications in the following subsections:

Antistrip Additive	702.07
Cement	701.01
Choker Aggregate	703.11
Cold Asphalt Concrete Pavement Aggregate	703.08
Cutback Asphalt	702.02
Emulsified Asphalt	702.03
Hydrated Lime	725.03
Mineral Filler	725.05
Water	725.01

Ensure that mixing temperature meets the requirements specified in Subsection 702.04.

Construction

404.03 Composition of Mixture (Job-Mix Formula). Ensure that the composition of cold asphalt concrete mixtures conforms to the following:

(a) Furnish a job-mix formula at least 21 days prior to production. Base the formula on a mix design using the type and grade of asphalt material that will be furnished for the project and of aggregate that will be produced for the project. Acceptable job-mix procedures and criteria are found in AI Manual Series number 14 and number 19. After reviewing the Contractor's proposed job-mix formula, the CO

will determine a job-mix formula with TV's and will notify the Contractor in writing.

(b) In the proposed job-mix formula, include definite single-value TV's for:

(1) The percentage of aggregate passing each specified sieve, based on the dry weight of aggregate. These percentages shall be within the range shown in Subsection 703.08, Table 703-5 or Table 703-6, as applicable.

(2) The percentage of bituminous material to be added, based on the total weight of mixture and corresponding residual asphalt content.

(3) The kind and percentages of additives to be used.

(4) The percentage of water, based on the total dry weight of the mixture.

(5) For emulsified asphalt only, the percentage to total fluids at compaction, based on the total dry weight of the mixture.

404.04 Performance. Perform construction in accordance with the following:

(a) Mixing Plant. Use asphalt mixing plants or pugmills that:

(1) Are manufactured for that purpose.

(2) Are in good working order.

(3) Are equipped with weighing or volumetric equipment capable of providing accurate control of the material entering the mixer.

(4) Interlock the aggregate feed controls with the asphalt material and other additives.

(b) Pavers. Use pavers that are:

(1) Self-contained, power-propelled units with adjustable vibratory screeds with full-width screw augers.

(2) Capable of spreading and finishing courses of asphalt mixture in widths at least 12 inches more than the width of one lane.

(3) Equipped with a receiving hopper with sufficient capacity to ensure a uniform spreading operation.

(4) Equipped with automatic feed controls that are properly adjusted to maintain a uniform depth of material ahead of the screed.

(5) Capable of being operated at forward speeds consistent with satisfactory laying of the mixture.

(6) Capable of producing a finished surface of the required smoothness and texture without segregating, tearing, shoving, or gouging the mixture.

(7) Equipped with automatic screed controls with sensors capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals that operate the screed to maintain grade and transverse slope.

(c) Surface Preparation. Prepare the surface in accordance with Sections 304, 306, 307, and 308, as applicable. Apply an asphalt tack coat to contact surfaces of curbing, gutters, manholes, and other structures in accordance with Section 407.

(d) Weather Limitations. Place cold asphalt concrete pavement on unfrozen, reasonably dry surface when the temperature of the road surface, in the shade, is above 60 °F, and it is not raining or snowing, or predicted to rain or snow within 24 hours after placement.

(e) Mixing. Introduce the material into the mixing plant according to the approved job-mix formula. Control the moisture content by adding water in the plant, covering the stockpile, drying the aggregate, or a combination of these methods as necessary to comply with the job-mix formula. When approved in writing by the CO, additives such as lime or cement may be incorporated into the mixture to correct moisture content.

When the aggregate is combined with asphalt materials other than emulsified asphalt, ensure that the aggregate does not contain more than 3 percent moisture and is at a temperature not less than 60 °F and not more than 225 °F. When the aggregate is combined with emulsified asphalt, ensure that the aggregate is at a temperature not less than 60 °F and not more than 175 °F. Determine the mixing time for each phase of the mixing operation from the nature of the aggregates, the job-mix formula, and the size of the batch. If the mixture is stockpiled, do not allow the pile to segregate such that the emulsified asphalt breaks.

(f) Hauling. Use vehicles conforming to Subsection 402.11.

(g) Placing & Finishing. Do not use mixtures produced from different plants unless the mixtures are produced in accordance with the same job-mix formula, use material from the same sources, and are approved.

Place the mixture with a paver that conforms to Subsection 404.04(b). Control horizontal alignment using a reference line. Automatically control the grade and slope from reference lines, a ski and slope control device, or dual skis. Use skis with a minimum length of 20 feet.

Offset and locate longitudinal joint according to Subsection 402.12.

For dense-graded mixtures, allow the surface to cure for not less than 10 days, and for open-graded mixtures, not less than 4 days, before covering with the next course. During this period, maintain the surface and keep it free of corrugations. Use an approved

material to patch all holes. Remove all excess blotter, dirt, or other objectionable substances before placing the following course or treatment.

(h) Compacting. Perform initial compaction through a minimum of three complete coverages with a steel-wheel roller that meets the requirements of Subsection 203.15(b). If necessary for dense-graded mixtures, aerate the material by periodically moving and exposing it in the stockpile or through manipulation in a windrow to remove excess moisture or cutter. When DESIGNATED IN THE SCHEDULE OF ITEMS, and prior to intermediate rolling, apply choker aggregate to the top layer only using aggregate spreading equipment designed for the controlled spreading of fine material. Uniformly spread the material to a depth that, when compacted, is sufficient to fill the voids of the asphalt concrete mat. Remove excess choker material by brooming.

Perform intermediate compaction through a minimum of two complete coverages of a self-propelled pneumatic-tire roller with a maximum tire pressure of 40 pounds per square foot.

Perform final compaction through two complete coverages with a static roller that meets the requirements of Subsection 203.15, and until all roller marks are eliminated. For open-graded mixtures, use a steel-wheel roller. When no choker aggregate is required, perform final compaction while the emulsion is still tacky.

Along forms, curbs, headers, walls, and other places not accessible to the rollers, use other equipment to obtain the minimum compaction of the mixture.

404.05 Acceptance Sampling & Testing. Perform acceptance sampling and testing in accordance with Subsections 402.15 through 402.18, with the following modifications:

(a) Use Table 404-1.

(b) Use Table 404-2.

(c) Compaction for the lot will be accepted if the requirements specified in Subsection 404.04(g) have been met and all roller marks are eliminated.

Measurement

404.06 Method. Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Calculate tonnage as the weight used in the accepted pavement. Make no deduction for the weight of bituminous material or water. No separate payment will be made for water or additives used in the mixture.

Payment

404.07 Basis. The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS, except that payment for sampling and testing will be made as follows:

Table 404-1. – Sampling and testing.

Type of acceptance	Material or Product	Property or Characteristic	Test Method or Specification	Frequency	Sampling Point
Production certification (subsection 105.04)	Asphalt cement	Contract requirements	AASHTO M 81 AASHTO M82 AASHTO M 140 AASHTO M 208 ASTM D 2026 as applicable	Daily	-
Tested conformance	Material source	Los Angeles abrasion	AASHTO T 96	Three times for each undeveloped source, [b] or once for all other sources	Material source
		Sodium sulfate soundness loss	AASHTO T 104		
		Durability index (course and fine)	AASHTO T 210		
	Aggregate	Fractured faces (course)[a]	FLH T 507		Cold feed prior to entering dryer
		Sand Equivalent value (fine)	AASHTO T 176, alternate method no. 2 (referee method)		
	Asphalt	Sample	Subsection 105.04(b)	Once for each 500 tons of mix, and not more than three times per day	At point of shipment delivery
	Job-mix formula	Contract requirements	Subsection 404.03	Once for each product or material change	-
Mix evaluation	Cold asphalt concrete pavement	Asphalt content	AASHTO T 164 Method B or E	Once for each 500 tons, not more than three times per day	At plant, in hauling units, or behind laydown machine before rolling
		Gradation	AASHTO T 30		

[a] Use only for gravel sources.
[b] An undeveloped source is a source that has not supplied aggregate for asphalt concrete within 365 days of the start of producing asphalt concrete for this particular project.

(a) Twenty-five percent of the lump sum, not to exceed 0.5 percent of the original contract amount, will be paid after all the testing facilities are in place, qualified sampling and testing personnel are identified, and the work being tested has started.

(b) Payment for the remaining portion of the lump sum will be prorated based on the total work completed.

(c) Payment for all or part of this pay item may be withheld if the Government assurance tests invalidate the Contractor's testing.

Table 404-2 - Mix tolerances.

Mixture Characteristic[a]	Tolerance
Residual asphalt content	TV ± 0.5
Total fluids in aggregate at compaction	TV ± 1.5

[a] For sieve size tolerance, refer to Table 703-5 or 703-6, according to the grading DESIGNATION IN THE SCHEDULE OF ITEMS.

Payment will be made under:

Pay Item		Pay Unit
404(01)	Cold bituminous pavement, _____ grading	Ton
404(02)	Cutback asphalt, grade _____	Ton
404(03)	Emulsified asphalt, grade _____	Ton
404(04)	Choker aggregate	Ton
404(05)	Sampling and testing	Lump Sum

Section 405 - Minor Cold Asphalt Concrete Pavement

Description

405.01 Work. Construct one or more courses of cold asphalt concrete plant mix on a prepared surface as SHOWN ON THE DRAWINGS. Have the surface approved by the CO in writing prior to placing cold asphalt concrete plant mix.

Cutback asphalt grade is designated as shown in AASHTO M 81 or M 82. Emulsified asphalt grade is designated as shown in AASHTO M 140 or M 208.

Materials

405.02 Asphalt Material. Ensure that asphalt material meets the requirements specified in Subsection 702.02 or 702.03, as applicable. The exact percent of asphalt material and the grade to be used will be furnished by the CO after requirements in Subsection 405.05 have been reviewed and evaluated. Ensure that mixing temperatures shall meet the requirements specified in Subsection 702.04.

405.03 Aggregate. Ensure that aggregate meets the requirements specified in Subsection 703.09, except for aggregate gradation. Maximum gradation size or suggested gradation designations will be SHOWN ON THE DRAWINGS.

405.04 Additives. Additives, such as filler, hydrated lime, and antistrip agents, may be used as necessary to meet specifications. Ensure that filler meets the requirements of AASHTO M 17; hydrated lime meets the requirements of AASHTO M 216, Type N; antistrip materials meet the requirements specified in Subsection 702.07; and choker aggregate meets the requirements specified in Subsection 703.11.

405.05 Job-Mix Formula. Submit a job-mix formula and supporting documentation, test results, and calculations for the material to be incorporated into the work. Include copies of laboratory test results and mix design data that demonstrate that the properties of the aggregate, additives, and mixture meet those requirements and criteria of local public agencies or the AI. After reviewing the Contractor's proposed job-mix formula, the CO will determine the final values for the job-mix formula to be used and notify the Contractor in writing.

Construction

405.06 Asphalt Concrete Mixing Plant. Ensure that plants used for preparing cold asphalt concrete mixtures are manufactured for that purpose, in good repair, and capable of mixing the material to a uniform consistency.

405.07 Hauling Equipment. Ensure that trucks used for hauling asphalt concrete mixtures have tight, clean, smooth metal beds that have been thinly coated with a material to prevent the mixture from adhering to the beds. Do not use petroleum derivatives or other coating material that contaminates or alters the characteristics of the mixture. Drain truck beds prior to loading, and ensure that each truck has a cover to

protect the mixture from weather. When necessary to ensure that the mixture will be delivered at the specified temperature, ensure that truck beds are insulated and covers securely fastened.

405.08 Pavers. Use pavers that are in good working order and have an adjustable vibrating screed or strike-off assembly, and an auger ahead of the screed to distribute the mixture. Use pavers that are capable of spreading and finishing courses of asphalt concrete plant mix material in the lane widths and thickness SHOWN ON THE DRAWINGS. Unless otherwise SHOWN ON THE DRAWINGS, towed-type pavers and Layton-type pavers or graders may be used to place and spread the asphalt concrete plant mix material.

405.09 Rollers. Ensure that all rollers meet the requirements specified in Subsections 203.15(b), (c), and (d). Where it is impractical to operate larger rollers, 3 to 5 ton rollers may be used. On walkways, 1-ton rollers may be used.

405.10 Weather Limitations. Do not place the asphalt concrete mixture when the base course is frozen, when the average temperature of the underlying surface upon which the asphalt concrete mixture is to be placed is less than 50 °F in the shade, or when it is raining or snowing, or predicted to rain or snow within 24 hours after placement.

405.11 Conditioning of Existing Surface. Immediately before placing the asphalt concrete mixture, clean the existing surface of loose or deleterious material.

Before placing the asphalt concrete mixture, paint the contact surfaces of curbing, gutters, manholes, and other structures with a thin, uniform coating of asphalt material.

405.12 Control of Asphalt Concrete Mixture. Supply a certification from the mixing plant stating that the mix conforms to the approved job-mix formula. The CO may reject any batch, load, or section of roadway that appears defective in gradation, asphalt content, or moisture content. Do not incorporate material rejected before placement into the pavement. Remove any rejected section of roadway. No payment will be made for the rejected materials or the removal of the materials, unless the Contractor requests that the rejected material be tested, at the Contractor's expense, under the following provisions:

(a) Obtain three representative samples and have them tested at a laboratory approved by the CO.

(b) If test results show that the material conforms to the tolerance shown in Table 405-1, payment will be made for the material and for its removal and testing.

405.13 Transporting, Spreading, & Finishing. Transport the mixture from the mixing plant to the point of use in vehicles that meet the requirements specified in Subsection 405.07.

Spread the mixture and strike it off to the grade and elevation established. Provide a maximum compacted lift thickness of 4 inches unless otherwise SHOWN ON THE DRAWINGS.

Table 405-1. - Allowable tolerances.

Mixture Characteristic	Tolerances
Residual Asphalt Content	Job-mix formula TV ±0.5
Sieve size:	
3/8 inch and larger	Job-mix formula TV ± 5.0
No. 4 to 3/8 inch	Job-mix formula TV ± 7.0
No. 200 No. 4	Job-mix formula TV ± 5.0
No. 200	Job-mix formula TV ± 2.0

Ensure that the longitudinal joint in any layer offsets that in the layer immediately below by approximately 6 inches. Where laydown requires placement of two adjacent panels to cover the surface of a traveled way, ensure that the longitudinal joint of the top layer is at the centerline. This requirement does not apply to turnouts, extra widening, or parking areas. Offset transverse joints in succeeding layers and in adjacent lanes at least 10 feet.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture may be placed and finished by using hand tools.

405.14 Compaction. Perform compaction with rollers that meet the requirements specified in Subsection 405.09. Perform initial compaction with steel-wheel rollers for a minimum of three complete coverage's. Between initial and final rolling on open-graded mixtures, apply a choker aggregate to the top layer only using aggregate spreading equipment designed for the controlled spreading of fine material. Uniformly spread the material to a depth that, when compacted, will be sufficient to fill the surface voids of the bituminous mat. Remove excessive choke material by brooming. Continue rolling, with a minimum of four complete coverage's and until no roller tracks remain, and while the bituminous material is still tacky.

Measurement

405.15 Method. Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Calculate the quantity of cold asphalt concrete plant mix as the tonnage of combined aggregate and asphalt material used in the accepted work. No separate payment will be made for asphalt material, water, or additives used in the mixture.

Payment

405.16 Basis. The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

Pay Item		Pay Unit
405(01)	Cold asphalt concrete plant mix, grade ____	Ton
405(02)	Cold asphalt concrete plant mix, grade ____	Square Yard

Section 407 - Asphalt Tack Coat

Description

407.01 Work. Apply an emulsified asphalt tack coat. Have the surface to be treated approved by the CO in writing prior to treatment.

Tack coat emulsified asphalt grade is designated as shown in AASHTO M 140 or M 208.

Materials

407.02 Requirements. Ensure that material conforms to the specifications in the following subsections:

Emulsified Asphalt.....702.03
Water.....725.01

Construction

407.03 Equipment. Use equipment that conforms to specifications in Subsection 410.04.

407.04 Surface Preparation. Immediately before the application of the tack coat, patch the surface to be treated and remove all foreign and loose material.

407.05 Weather Limitations. Apply asphalt tack coat on a dry, unfrozen surface when the surface temperature in the shade is above 35 °F and rising.

407.06 Asphalt Application. Where slow-setting emulsified asphalt is used, dilute it by adding an equal amount of water to the emulsified asphalt.

Apply the asphalt in accordance with Subsection 410.08 at a rate of 0.03 to 0.15 gallons per square yard. When a tack coat cannot be applied with an asphalt distributor spray bar, apply the tack coat uniformly and completely by fogging with a hand spray attachment or by another approved method. Ensure that the surfaces of adjacent structures and trees are protected from splattering and marring.

If excess asphalt material is applied, squeegee the excess from the surface. Allow the tacked surfaces to completely cure before placing the covering course. Place the covering course within 4 hours of placing the tack coat.

407.07 Acceptance. Emulsified asphalt will be evaluated for acceptance under Subsection 106.05.

Provide the minimum number of samples specified in Table 410-4.

Measurement

407.08 Method. Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Water used for diluting emulsified asphalt will not be included in the quantities for PAY ITEMS 407(01) or 407(02), and will not be paid for separately.

Payment

407.09 Basis. The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

Pay Item		**Pay Unit**
407(01)	Tack coat, grade _____	Ton
407(02)	Tack coat, grade _____	Gallon

Section 408 - Asphalt Prime Coat

Description

408.01 Work. Apply a cutback or emulsified asphalt prime coat. Have the surface approved in writing by the CO prior to applying the prime coat.

Prime coat asphalt grade is designated as shown in AASHTO M 140 or M 208 for emulsified asphalt, and AASHTO M 81 or M 82 for cutback asphalt.

Materials

408.02 Requirements. Ensure that material conforms to the specifications in the following subsections:

Blotter	703.12
Choker Aggregate	703.11
Cutback Asphalt	702.02
Emulsified Asphalt	702.03
Water	725.01

Construction

408.03 Equipment. Use equipment that conforms to Subsection 410.04.

408.04 Surface Preparation. Immediately before applying the prime coat, lightly blade the surface and roll it with a smooth-wheel roller. Ensure that the moisture content of the top 1 inch of the surface to be treated is slightly damp.

408.05 Weather Limitations. Apply prime coat when the air temperature in the shade and the pavement surface temperature are at least 50 °F and rising, and when the weather is not foggy or rainy.

408.06 Asphalt Application. When required by the CO, lightly spray the surface with water before applying the prime coat. In order to obtain optimum penetration, apply cutback asphalt in accordance with Subsection 410.08 at a rate of 0.10 to 0.50 gallons per square yard.

Where using an emulsified asphalt that is not formulated as a penetrating prime coat material, dampen the roadway surface and scarify 1 inch to 2 inches deep. Dilute the emulsified asphalt by adding an equal amount of water. Apply the diluted emulsified asphalt in accordance with the Subsection 410.08 at a rate of 0.10 to 0.30 gallons per square yard. Immediately process, respread, and compact the material.

Cure surfaces primed with emulsified asphalt for not less than 24 hours, and surfaces primed with cutback asphalt for not less than 5 days before covering with the next course.

Until the next course is placed, maintain the primed surface and keep it free of corrugations.

Where traffic is routed over a primed surface before the asphalt material has been completely absorbed, or to minimize damage by rain, spread blotter to cover the unabsorbed asphalt. If an emulsified asphalt is used, use choker aggregate. When cutback asphalt is used, do not apply the blotter material for at least 4 hours following application of the asphalt. Remove all excess blotter, choke, dirt, or other deleterious material and repair all damaged areas before placing the next course. Dispose of asphalt material in accordance with Subsection 202.04(a).

408.07 Acceptance. Cutback asphalt and emulsified asphalt will be evaluated for acceptance under Subsection 106.05.

Blotter will be evaluated for acceptance under Subsection 105.03.

Provide the minimum number of samples and tests specified in Table 410-4.

Measurement

408.08 Method. Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Water used for diluting emulsified asphalt will not be included in the quantity for PAY ITEMS 408(01) or 408(02) and will not be paid for separately.

Payment

408.09 Basis. The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will made under:

Pay Item		**Pay Unit**
408(01)	Prime coat, grade _____	Ton
408(02)	Prime coat, grade _____	Gallon
408(03)	Blotter	Ton
408(04)	Blotter	Cubic Yard

Section 409 - Slurry Seal

Description

409.01 Work. Apply an asphalt slurry seal mixture. Have the surface approved by the CO in writing prior to placing the slurry seal.

Slurry seal type is designated as shown in Table 703-8.

Materials

409.02 Requirements. Ensure that material conforms to the specifications in the following subsections:

Emulsified Asphalt	702.03(d)
Mineral Filler	725.05
Slurry Seal Aggregate	703.10
Water	725.01

Construction

409.03 Composition of Mixture (Job-Mix Formula). Furnish a slurry seal mixture of aggregate, water, emulsified asphalt, and additives in accordance with ASTM D 3910 and ISSA T 114. Ensure that the mixture meets the applicable aggregate gradation shown in Table 703-8 and has the following residual asphalt contents, based upon weight of dry aggregate:

- Type I—Residual asphalt between 10.0 percent and 16.0 percent.
- Type II—Residual asphalt between 7.5 percent and 13.5 percent.
- Type III—Residual asphalt between 6.5 percent and 12.0 percent.

Submit a written job-mix formula for approval at least 21 days before production that includes the following:

***(a) Aggregate Gradation Values*.** Provide the representative value for each sieve size for the aggregate blend.

(b) Emulsified Asphalt Content. Provide the residual asphalt content, as a percent by weight of dry aggregate.

***(c) Samples*.** Provide samples of the aggregate, emulsified asphalt, and mineral filler when SHOWN ON THE DRAWINGS.

(d) Laboratory Test Reports & Mix Design Data. Provide copies of all laboratory test reports and mix design data verifying that the material meets the requirements of Subsection 409.02 and the job-mix formula.

The job-mix formula will be evaluated and approved in accordance with Subsection 401.03.

409.04 Equipment. Furnish equipment with the following capabilities:

***(a) Slurry Seal Mixer*.** Furnish a slurry seal mixer with the following features and capabilities:

(1) Self-propelled.

(2) Continuous-flow mixing.

(3) Calibrated controls.

(4) Easily readable metering devices that accurately measure all raw materials before entering the pugmill.

(5) Automated system for sequencing in all raw materials to ensure constant slurry mixture.

(6) Mixing chamber to thoroughly blend all ingredients together.

(7) Fines feeder with an accurate metering device for introducing additive into the mixer, where the aggregate is introduced into the mixer.

(8) A pressurized water system with a fog-type spray bar capable of fogging the surface immediately ahead of the spreading equipment at a rate of 0.03 to 0.06 gallons per square yard.

(9) Proportioning system that is accurate for measuring all material independent of the engine speed.

(10) Minimum speed of 60 feet per minute and maximum speed of 180 feet per minute.

(11) Minimum storage capacity of 7 tons.

(12) Capability in accordance with ISSA Performance Guidelines A 105.

***(b) Mechanical-Type Single Squeegee Spreader Box*.** Furnish with the following capabilities:

(1) Attaches to the slurry seal mixer.

(2) Flexible squeegee in contact with the surface to prevent loss of slurry.

(3) Adjustable to assure a uniform spread over varying grades and crowns.

(4) Adjustable in width with a flexible strike-off.

(5) Augers for uniform flow to edges.

(c) Auxiliary Equipment. Furnish hand squeegees, shovels, and other equipment necessary to perform the work. Provide cleaning equipment that includes, but is not limited to, power brooms, air compressors, water-flushing equipment, and hand brooms for surface preparation.

(d) Pneumatic-Tire Roller. When SHOWN ON THE DRAWINGS, provide a pneumatic-tire roller with the following features:

(1) Smooth tread tires of equal size.

(2) Minimum ground pressure of tire greater than 50 pounds per square inch.

409.05 Surface Preparation. Immediately before placing the slurry seal, clean the existing surface of loose or deleterious material.

409.06 Weather Limitations. Apply slurry seal when the air temperature in the shade and the surface temperature are at least 60 °F and rising, and when the weather is not foggy, rainy, or overcast.

409.07 Slurry Seal Application. Mix the slurry seal using a slurry seal mixer. Fog the surface with water immediately preceding the spreader.

Blend the additive with the aggregate using the fines feeder. Prewet the aggregate in the pugmill immediately before mixing with the emulsified asphalt. Stockpile aggregate accordingly to Subsection 305.04.

Mix the slurry seal for a maximum of 4 minutes. Ensure that the slurry seal mixture is of the desired consistency as it leaves the mixer, and that it conforms to the approved job-mix formula. If approved by the CO, the mineral filler and the emulsified asphalt content may be adjusted during construction to conform to variations in field conditions.

Carry sufficient slurry seal mixture in the spreader to completely cover the surface. Spread the mixture with a mechanical-type single squeegee spreader box. In areas not accessible to the spreader box, use hand squeegees to work the slurry seal mixture.

Remove or repair ridges or bumps in the slurry surface.

When required, roll the slurry surface, providing a minimum of five coverages, to completely cure it prior to opening to traffic. Cure is complete when clear water can be pressed out of the slurry mixture with a piece of paper without discoloring the paper.

409.08 Acceptance. Emulsified asphalt will be evaluated for acceptance under Subsection 106.05.

Aggregate will be evaluated for acceptance under Subsection 105.03.

Provide the minimum number of samples and tests specified in Table 409-1, in accordance with Section 160.

Measurement

409.09 Method. Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment

409.10 Basis. The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

Pay Item	**Pay Unit**
409(01) Slurry seal, type _____	Square Yard

Table 409-1. – Sampling and testing.

Type of acceptance	Material or Product	Property or Characteristic	Test Method or Specification	Frequency	Sampling Point
Production certification	Emulsified asphalt[a]	Contract requirements	AASHTO M 140 AASHTO M 208 as applicable	Each shipment	-
Tested conformance	Material source[b] (Contractor-located source)	Los Angeles abrasion	AASHTO T 96	Three times for each undeveloped source, [c] or once for all other sources	Material source
	Slurry seal aggregate	Gradation, Table 703-8	AASHTO T 27 and T 11	Once for each 2,000 yd^2, but not than three times per day	
		Sand equivalent value	AASHTO T 176, alternate method number 2 (referee method)		
	Emulsified asphalt	Sample	Subsection 106.04(b)	Each tanker, including all trailers	At point of shipment delivery

[a] Use in work permitted before sampling and testing for conformance.
[b] See Subsection 105.03. Testing not required when using Government-provided material source.
[c] An undeveloped source is a source that has not supplied slurry seal aggregate within 365 days of the start of producing slurry seal aggregate for this project.

Section 410 - Asphalt Surface Treatment

Description

410.01 Work. Construct a single or multiple asphalt surface treatment course. Have the surface approved by the CO in writing prior to placing the asphalt surface treatment.

Surface treatment aggregate is designated as shown in Tables 410-1, 410-2, and 410-3.

Table 410-1. - Approximate quantities of material for single-course surface treatment.

Sequence of Operations	Treatment Designation and Aggregate Gradation				
	B	C	D	E	F
Apply asphalt material (gal/yd^2)					
Emulsified asphalt	0.45	0.38	0.28	0.20	0.20
Cutback asphalt	0.40	0.25	0.20	0.15	0.15
Asphalt cement	0.40	0.25	0.20	0.15	0.15
Spread aggregate[a,b] (pounds/yd^2)	45	28	23	15	20

[a.] See Table 703-7 for aggregate gradations.
[b.] Aggregate weights are for aggregates that have a bulk specific gravity of 2.65, as determined by AASHTO T 84 and T 85. Make proportionate corrections when the aggregate furnished has a bulk specific gravity above 2.75 or below 2.55.

The grade of asphalt is designated as shown in AASHTO M 20 or M 226 for asphalt cement, Subsection 702.03 for emulsified asphalt, and AASHTO M 81 or M 82 for cutback asphalt, or in applicable State department of transportation specifications for the grade specified.

A presurface treatment conference will be held at least 10 working days prior to the beginning of surface treatment operations. At that time, the Contractor and the CO will discuss methods of accomplishing all phases of the work, including operations, work schedules, work force, quality control systems, spill prevention and contingency plans, and material application rates.

Materials

410.02 Requirements. Ensure that material conforms to the specifications in the following subsections:

Table 410-2 - Approximate quantities of material for multiple-course surface treatment (using cutback asphalt).

Sequence of Operation	Treatment Designation Aggregate Gradation [a,b]				
	AT-19	**AT-27**	**AT-33**	**AT-38**	**AT-61**
First Course:					
Apply asphalt material (gal/yd^2)	0.22	0.25	0.15	0.30	0.20
Spread aggregate (pounds/yd^2)					
Grading D	25	-	-	-	-
Grading C	-	35	-	-	-
Grading B	-	-	40	50	-
Grading A	-	-	-	-	44
Second Course:					
Apply asphalt material (gal/yd^2)	0.13	0.25	0.30	0.35	0.40
Spread aggregate (pounds/yd^2)					
Grading E	10	15	-	-	-
Grading D	-	-	12	20	-
Grading C	-	-	-	-	20
Third Course:					
Apply asphalt material (gal/yd^2)	-	-	0.15	-	0.20
Spread aggregate (pounds/yd^2)					
Grading E	-	-	8	-	12
Totals:					
Asphalt material (gal/yd^2)	0.35	0.50	0.60	0.65	1.00
Aggregate (pounds/yd^2)	35	50	60	70	110

[a] See Table 703-7 for aggregate gradations.
[b] Aggregate weights are for aggregates that have a bulk specific gravity of 2.65, as determined by AASHTO T 84 and T 85. Make proportionate corrections when the aggregate furnished has a bulk specific gravity above 2.75 or below 2.55.

Construction

410.03 Material Submittals. For surface treatments, submit the information and samples shown below for approval at least 21 days before production.

***(a) Aggregate Samples*.** Provide 80 pounds from each stockpile produced and the gradation range represented by each.

***(b) Aggregate Gradation TV's*.** Submit the proposed percentage of each stockpile to be used and the proposed TV for each sieve size.

***(c) Asphalt Temperature*.** Ensure that asphalt application temperatures conform to Table 702-1.

***(d) Spread Rates*.** Furnish proposed spread rates for the asphalt material and aggregate.

Table 410-3 - Approximate quantities of material for multiple-course surface treatment (using emulsified asphalt or asphalt cement[a]).

Sequence of Operation	Treatment Designation Aggregate Gradation [b,c]				
	E-19	**E-27**	**E-33**	**E-38**	**E-61**
First Course:					
Apply asphalt material (gal/yd^2)	0.45	0.35	0.45	0.50	0.50
Spread aggregate (pounds/yd^2)					
Grading D	22	-	-	-	-
Grading C	-	30	-	-	-
Grading B	-	-	36	40	-
Grading A					70
Second Course:					
Apply asphalt material (gal/yd^2)	0.25	0.25	0.25	0.25	0.45
Spread aggregate (pounds/yd^2)					
Grading E	10	10	-	-	-
Grading D	-	-	16	16	-
Third Course:					
Apply asphalt material (gal/yd^2)	-	-	-	-	0.25
Spread aggregate (pounds/yd^2)					
Grading E	-	-	-	-	8
Totals:					
Asphalt material (gal/yd^2)	0.70	0.85	0.95	1.00	1.35
Aggregate (pounds/yd^2)	35	50	60	70	110

[a] For asphalt cement spread rates, multiply the asphalt material spread rates shown in the table by 0.68.
[b] See Table 703-7 for aggregate gradations.
[c] Aggregate weights are for aggregates that have a bulk specific gravity of 2.65, as determined by AASHTO T 84 and T 85. Make proportionate corrections when the aggregate furnished has a bulk specific gravity above 2.75 or below 2.55.

410.04 Equipment. Ensure that all equipment is in good working order. Furnish the equipment shown below:

(a) Asphalt Distributor. Furnish an asphalt distributor with the following features and capabilities:

(1) Capable of heating asphalt evenly.

(2) Full-circulation spray bar adjustable to at least 15 feet wide.

(3) Positive controls, including tachometer, pressure gage, volume-measuring device, or calibrated tank, to uniformly deposit asphalt over the full width within 0.02 gallons per square yard of the required rate.

(4) Thermometer for measuring the asphalt temperature in the tank.

(b) Rotary Power Broom. Furnish a rotary power broom equipped to control the vertical broom pressure.

(c) Pneumatic-Tire Rollers. Furnish a minimum of two pneumatic-tire rollers with the following features and capabilities:

(1) Minimum compacting width of 5 feet.

(2) Minimum ground contact pressure of 80 pounds per square inch, with all tires exerting equal contact pressure.

(3) Gross weight adjustable within the range of 2,000 to 3,700 pounds per inch of compaction width.

(4) Self-propelled.

(d) Aggregate Spreader. Furnish an aggregate spreader with the following features:

(1) Self-propelled.

(2) Minimum of four pneumatic tires on two axles.

(3) Positive controls to uniformly deposit the aggregate over the full width of asphalt within 10 percent by weight of the required rates.

(e) Two-Way Communication. Provide two-way radio communication between the asphalt distributor and aggregate spreader.

(f) Other Equipment. When approved, other equipment of proven performance may be used in addition to, or in lieu of, the equipment specified.

410.05 Surface Preparation. Immediately before placing any layer of the surface treatment, remove loose dirt and other objectionable material from the existing surface.

Apply surface treatments to an existing asphalt surface only when the surface is dry. Prior to application, allow a newly constructed cold or road mix surface to cure for at least 21 days for a cutback asphalt mix, and at least 14 days for an emulsified asphalt mix, unless otherwise approved by the CO.

When applying surface treatments to existing aggregate surfaces, ensure that the surface is dry if the aggregate was primed, and slightly damp if not primed. If the aggregate surface is primed, allow a prime coat curing period of at least 5 days for cutback asphalt and 24 hours for emulsions, unless otherwise approved by the CO.

Fog seal patches SHOWN ON THE DRAWINGS or listed in the SPECIAL PROJECT SPECIFICATIONS using CSS–1 emulsion, diluted with an equal part of water, at 0.15 gallons/yd^2, unless another rate is SHOWN ON THE DRAWINGS.

410.06 Weather Limitations. Apply surface treatments with aggregate only when the ambient air and surface temperatures are above 60 °F and rising, when the weather is not foggy or rainy, and when rain is not forecast for at least 24 hours after application.

Apply fog seals only when the ambient air and surface temperatures are above 50 °F and rising, when the weather is not foggy or rainy, and when rain is not forecast for at least 24 hours after application.

For all work:

(a) Ensure that humidity is less than 75 percent as measured by the sling psychrometer method.

(b) Complete application of the surface treatment 2 hours before sunset.

(c) Unless otherwise approved by the CO, construct fog seals and single-course surface treatments between June 1 and September 1, and multiple-course surface treatments between June 1 and September 15.

410.07 Production Startup Procedures for Surface Treatment. Provide 7 days advance notice before constructing any asphalt surface treatments containing aggregate, and also use these startup procedures when resuming production after termination due to nonconforming work.

Calibrate each asphalt distributor's bar height, nozzle angle, pump pressure, and longitude and transverse spread rates in accordance with ASTM D 2995. If different asphalt distributors are used throughout the project, calibrate each prior to use on the project.

On the first day of production of each surface treatment layer, whenever there is a change in the surface texture or the aggregate TV's construct a 500-foot control strip one lane wide. Locate the control strip on the project as designated.

Construct the control strip using material, laydown, and compaction procedures intended for the remainder of the surface treatment. Cease production after construction of the control strip until the material, the control strip, and the asphalt distributor calibration procedures are evaluated and accepted.

Acceptable control strips may remain in place, and will be accepted as a part of the completed surface treatment.

Repeat this control strip process until an acceptable control strip is produced.

410.08 Asphalt Application. Protect the surfaces of nearby objects to prevent spattering or marring. For transverse construction joints, spread building paper on the surface for a sufficient distance from the beginning and end of each application so that the flow through the distributor nozzles may be started and stopped on the paper.

The CO may make adjustments for variations in field conditions. Apply the asphalt uniformly with an asphalt distributor with the spray bar height set for triple overlap. Move the distributor forward at the proper application speed at the time the spray bar is opened. Use care not to apply excess asphalt at the junction of spreads.

Ensure that the length of spread is no more than what can be covered with aggregate within 1 minute of the asphalt application.

Correct skipped areas or deficiencies. Remove and dispose of paper or other material used, in accordance with Subsection 202.04(a).

410.09 Aggregate Application. When using emulsified asphalt, moisten the aggregate to remove its dust coating.

Stockpile aggregate according to Subsections 305.03 and 305.04.

Apply the aggregate uniformly with an aggregate spreader immediately after the asphalt is applied. Operate the aggregate spreader so the asphalt is covered with the aggregate before wheels pass over it. During part-width construction, leave a strip of the sprayed asphalt approximately 6 inches wide uncovered to permit an overlap of the asphalt material.

Immediately correct excesses and deficiencies by brooming, or by the addition or removal of aggregate, until a uniform texture is achieved. Use hand methods in areas not accessible to power equipment.

Make the first roller pass to seat the aggregate immediately after the aggregate is applied. Operate rollers at a maximum speed of 5 miles per hour. Do not permit the aggregate to be displaced by pickup or sticking of materials to the tire surface. Ensure that the amount of rolling is sufficient to uniformly and thoroughly bond the aggregate over the full width. Make a minimum of three complete coverages. Ensure that rolling is completed within 1 hour after the asphalt is applied to the surface.

410.10 Fog Seal. To construct a fog seal, apply a slow-setting emulsified asphalt diluted with an equal amount of water onto an existing asphalt surface. Apply the diluted emulsified asphalt in accordance with Subsection 410.08 at a rate of 0.10 to 0.15 gallons per square yard, depending on the condition of the existing surface. Allow the fog seal to penetrate undisturbed for at least 2 hours, or until the emulsified asphalt breaks and is substantially absorbed into the existing surface. Then lightly cover remaining spots of excess asphalt with blotter before opening the surface to traffic.

410.11 Single-Course Surface Treatment. To construct a single-course surface treatment, apply asphalt onto an existing asphalt surface, immediately followed by a single, uniform application of aggregate. Apply the asphalt and aggregate in accordance with Subsections 410.08 and 410.09 at the approximate rates shown in Table 410-1. Determine the exact application rates based on approved control strips.

Unless the road is closed to all traffic for the duration of the placement of the surface treatment, use a pilot car to limit traffic speeds. During the initial 45 minutes after rolling, limit the traffic speeds to 10 mph. Limit traffic speeds to 20 mph for 24 hours. At all times, operate hauling equipment in a prudent manner and at speeds that will not damage the new surface treatment or create a hazard to the traveling public.

Lightly broom the aggregate surface on the morning after construction. Do not displace embedded material.

Maintain the surface for 4 days after the application of the last layer of aggregate by distributing blotter to absorb any free asphalt, by repairing areas deficient in aggregate, and by sweeping excess material from the surface using a rotary power broom. Broom when the air temperature is less than 75 °F. Do not displace embedded material when brooming.

410.12 Multiple-Course Surface Treatment. To construct a multiple-course surface treatment, apply multiple layers of asphalt and aggregate. Apply each asphalt and aggregate layer in accordance with Subsections 410.08 and 410.09, and at the approximate rates shown in Table 410-2 or 410-3. Determine the exact application rates based on approved control strips. When approved by the CO, a steel-wheeled roller with a minimum weight of 8.8 tons may be substituted for one of the pneumatic tire rollers.

Maintain the surface and limit traffic in accordance with Subsection 410.11.

Wait at least 72 hours between application of the layers when using a cutback asphalt, and 24 hours when using an emulsified asphalt. No wait is necessary when using asphalt cement.

410.13 Acceptance. Asphalt cement, emulsified asphalt, and cutback asphalt will be evaluated for acceptance under Subsection 106.05.

Asphalt treatment aggregate and blotter will be evaluated for acceptance under Subsection 105.03.

Provide the minimum number of samples and tests specified in Table 410-4, in accordance with Section 160.

Measurement

410.14 Method. Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Water used for diluting emulsified asphalt will not be included in the quantity for PAY ITEM 410(04), and will not be paid for separately.

Payment

410.15 Basis. The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

Pay Item		Pay Unit
410(01)	Surface treatment aggregates, designation _____	Ton
410(02)	Surface treatment aggregates, designation _____	Cubic Yard
410(03)	Asphalt cement, grade _____	Ton
410(04)	Emulsified asphalt, grade _____	Ton
410(05)	Cutback asphalt, grade _____	Ton
410(06)	Blotter	Ton
410(07)	Blotter	Cubic Yard

Table 410-4. – Sampling and testing.

Type of acceptance	Material or Product	Property or Characteristic	Test Method or Specification	Frequency	Sampling Point
Production certification	Asphalt[a] cement	Contract requirements	AASHTO M 20 or M 226 as applicable	Each Shipment	-
	Emulsified asphalt[a]		Subsection 702.03		
	Cutback asphalt[a]		AASHTO M 81 or M 82 as applicable		
Tested conformance	Material source[b] (Contractor-located source)	Los Angeles abrasion	AASHTO T 96	Three times for each undeveloped source, [c] or once for all other sources	Material source
		Sodium sulfate soundness loss	AASHTO T 104		
		Durability index (course and fine)	AASHTO T 210		
		Density	AASHTO T 19		
		Coating and stripping of bitumen-aggregate	AASHTO T 182		
	Asphalt surface treatment aggregate	Gradation, Table 703-8[d]	AASHTO T 27 and T 11	Once for each 500 tons of mix, but not less than three times per day of production	At stockpile
		Fractured faces (course)[d,e]	FLH T 507		
		Flakiness index[d]	FLH T 508		
	Blotter and choker aggregate	Gradation	AASHTO T 27	Once for each 500 tons of mix, but not less than three times per day of production	Material source
		Liquid limit	AASHTO T 89		
		Sand equivalent	AASHTO T 176		
		Plasticity index	AASHTO T 90		
	Asphalt cement	Sample	Subsection 105.04(b)	Each tanker, including all trailers	At point of shipment delivery
	Emulsified asphalt				
	Cutback asphalt				

[a.] Use in work is permitted prior to sampling and testing for conformance.
[b.] See Subsection 105.06. Testing not required when using Government-provided material source.
[c.] An undeveloped source is a source that has not supplied surface treatment aggregate within 365 days of the start of producing surface treatment aggregate for this project.
[d.] Applies to each aggregate grade furnished.
[e.] Use only for gravel sources.

Section 411 - Miscellaneous Asphalt Pavement Seals

Description

411.01 Work. Apply pavement sealing material(s) or rejuvenator to pavement surfaces SHOWN ON THE DRAWINGS. The pavement seal may require blotter or color treatment as SHOWN ON THE DRAWINGS. Have the surface approved by the CO in writing prior to placing the miscellaneous asphalt pavement seal.

Materials

411.02 Requirements. Meet the following requirements for materials:

(a) Seal Material. As the primary component of the pavement seal material, use slow-setting asphalt emulsion that conforms to AASHTO M 140 or M 208. Submit a manufacturer's Certificate of Compliance with each shipment of asphalt emulsion. Mix asphalt emulsions with additives that prevent bleeding. Seal materials may be diluted with water to improve penetration into the pavement surface or to improve consistency.

(b) Rejuvenation Material. Dilute rejuvenation materials by two parts concentrate to one part water. Ensure that the concentrate meets the requirements specified in Table 411-1.

(c) Additive Materials. Materials such as clays, slates, fibers, carbon black, and polymers may be added to emulsified asphalt, provided that the manufacturer's product literature is reviewed and approved by the CO prior to application. If the pavement seal material is blended with sand, use sand that has clean, hard, durable, uncoated particles, and is free of clay lumps and organic matter, with 100 percent passing the No. 30 sieve and a maximum of 5 percent passing the No. 200 sieve. The sand must have a gradation that helps control segregation and promotes suspension during product application. Do not add more than 3 pounds of sand to each gallon of applied material.

(d) Color Treatment. When SHOWN ON THE DRAWINGS, use color treatments. Carefully mix and apply color additives according with the manufacturer's instructions, so that a consistent color and durable seal are obtained. Asphacolor is the only known material to meet these requirements. If other products are proposed, provide manufacturer's literature that shows similar color, consistency, and durability characteristics.

(e) Blotter. Meet the requirements specified in Subsection 703.12.

(f) Water. Meet the requirements specified in Subsection 725.01.

411.03 Sampling. When directed by the CO, sample materials that are used in the work. Give the CO the opportunity to witness sampling. The CO will be responsible for testing.

Construction

411.04 Weather Limitations. Apply asphalt pavement seals only when the ambient air and surface temperatures are above 50 °F and rising, when the weather is not foggy or rainy, and when rain is not forecast for at least 24 hours after application.

Table 411-1 - Rejuvenator concentration requirements.

Test	Test Method		Requirements	
	ASTM	AASHTO	Minimum	Maximum
On emulsion:				
Viscosity at 77 °F, SFS	D 224	T 59	15	40
Residue, percent[a]	D 224 (mod.)	T 59 (mod.)	60	65
Miscibility test[b]	D 224 (mod.)	T 59 (mod.)	No coagulation	
Sieve test, percent[c]	D 224 (mod.)	T 59 (mod.)	-	0.1
Particle charge test	D 224	T 59	Positive	-
On residue from distillation:				
Flash point, COC, °F	D 92	T 48	196	
Viscosity at 140 °F	D 445	-	100	200
Asphaltenes, %	D 2006-70	-		1.0
Maltene distribution ratio,[d]	D 2006-70	-	0.3	0.6
$\frac{PC+A1}{S+A2}$				
PC/S ratio[d]	D 2006-70	-	0.5	-
Saturated hydrocarbons, S	D 2006-70	-	21	28

a. For the ASTM D 244 modified evaporation test for percent of residue, heat a 2 ounce sample to 300 °F until foaming ceases, then cool immediately and calculate results.
b. Use test procedure identical to ASTM D 244–60, but use .02 percent normal calcium chloride solution in place of distilled water.
c. Use test procedure identical to ASTM D 244, but use distilled water in place of 2 percent sodium oleate solution.
d. Chemical composition by ASTM method D 2006–70, where PC = polar compounds, A2 = first acidaffins, A1 = second acidaffins, and S = saturated hydrocarbons.

411.05 Equipment. For all materials, use the distribution equipment that is capable of placing a uniform consistency of the material and enabling a uniform application over variable widths of surface. The required application rate may be obtained by making multiple applications. Use equipment for storing and applying of liquid and slurry products that include accurate volume measuring devices and a calibrated tank. The CO may require transport or application equipment to be weighed when full and when empty, if volume-measuring equipment is inadequate.

411.06 Preparation of Surface. Prior to placing the pavement seal, ensure that the surface of the pavement is clean and free from dust, dirt, or other loose foreign matter, grease, oil, or any type of objectionable surface film. Accumulations of oil or grease may be removed by pressure washing, grinding, or burning and scraping. Remove existing painted stripes if SHOWN ON THE DRAWINGS.

Clean all cracks wider than 1/8 inch by removing accumulated dirt and vegetation, and blow the cracks out with compressed air to a depth of at least three times the crack width. Fill transverse cracks that are more than 1/8 inch wide according to Subsections 414.04 and 414.05. Other cracks that are more than 1/8 inch wide may be filled with pavement seal materials prior to application of seal materials over the entire surface.

411.07 Pavement Seal Application With or Without Color Treatment. Application may be by hand-held spray equipment, asphalt distributor, squeegee, or slurry seal spreader box. Spread the seal material in two directions, 180° from each other. The CO may require an additional application on small areas of pavement that have more surface voids, where voids have prevented adequate coverage, or where uneven application exists.

Obtain the minimum residue application rate of 1 lb/yd^2 over the entire surface to be treated. Ensure that residue consists of the asphalt cement portion of the emulsified asphalt and nonevaporative additive materials (such as clays, slates, fibers, polymers, and sand) that are suspended in the emulsion when applied. Application rates may be adjusted up or down by 0.15 lbs residue per square yard by the CO to compensate for pavement surface absorption and roughness.

Readily determine the volume of emulsion used prior to, during, and after application. Final payment will be based on meeting the specified application rate of residue. The CO will determine the weight of residue per liter by drying field samples from the project to constant weight.

411.08 Blotter Application. When blotter is included as a PAY ITEM, apply it at 10 lbs/yd^2 to areas SHOWN ON THE DRAWINGS. Complete the application within 24 hours of the emulsified asphalt application. The CO may require redistribution of blotter during the first 3 days of the pavement seal curing period.

411.09 Rejuvenator Application. Apply diluted rejuvenator at a rate between 0.05 and 0.10 gallons per square yard. The exact rate will be determined by the CO. Two hours after application, blot the treated surface with 1 lb. to 3 lbs. of blotter sand per square yard. Allow the required cure time of 24 to 48 hours before brooming the sand from the surface.

411.10 Surface Maintenance. Prevent asphalt pickup under traffic for 4 days after treatment. Open the treated pavement surface to traffic within 24 hours following treatment. When directed by the CO, apply blotter sand to the sealed pavement to prevent asphalt pickup by vehicles. The CO may require removal of loose blotter by brooming after the maintenance period. After the treatment has been open to traffic for 4 days, repair any areas that are damaged by traffic or that are peeling or cracking. All damage repair is the responsibility of the Contractor.

411.11 Acceptance. Acceptance for pavement seal with or without color will be as follows:

If laboratory-quality assurance tests on samples taken during application do not contain enough residue to meet the specified application rates established by the CO in Subsection 411.07, the CO may require the application of more material or may reduce payment. The following factors will be used to determine whether the specified application rate has been obtained:

(a) The average unit weight of the field samples, determined by weighing 0.25 gallons to within ± 0.01g.

(b) The percent residue per gallon on a by-weight basis.

(c) The total volume of product applied.

The rejuvenator will be evaluated for acceptance under Subsection 106.05.

Blotter will be evaluated for acceptance under Subsection 105.03.

Measurement

411.12 Method. Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Water used for diluting the pavement seal or rejuvenator will not be included in the quantity for PAY ITEMS 411(01), 411(02), or 411(04), and will not be paid for separately.

Payment

411.13 Basis. The accepted quantities will be paid for at the contract unit price for the PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

Pay Item		Pay Unit
411(01)	Pavement seal	Square Yard
411(02)	Pavement seal with color treatment	Square Yard
411(03)	Blotter	Square Yard
411(04)	Asphalt rejuvenator	Square Yard

Section 413 - Asphalt Pavement Milling

Description

413.01 Work. Remove asphalt pavement using a cold milling process.

Construction Requirements

413.02 Equipment - Milling Machine. Furnish equipment in good working order and with the following capabilities and features:

(a) Self-propelled.

(b) Sufficient power, traction, and stability to accurately maintain depth of cut.

(c) Capable of removing the pavement thickness to provide profile and cross slope.

(d) Automatic system to control grade elevations by referencing from the existing pavement by means of a ski or matching shoe or from an independent grade control.

(e) Automatic system to maintain cross slope.

(f) System to effectively limit dust and other particulate matter from escaping removal operations.

(g) Loading system or adequate support equipment to completely recover milled material at removal rate.

(h) Cutting width equal to at least one-third of the lane width.

413.03 Milling. Use a longitudinal reference to accurately guide the machine. References may include a curb, the edge of pavement, or a string attached to the pavement surface. Mill in a longitudinal direction to the depth SHOWN ON THE DRAWINGS.

Mill the transverse slope to within ¼ inch in 10 feet of the required slope. Transition from one transverse slope to another at a uniform rate. Uniformly mill the entire roadway lane width so the cross section of the new surface forms a straight line.

Transition between different depths of cut at a uniform rate of ½ inch of depth per 25 feet. At the beginning and end of the milling work, construct a smooth transition to the original surface at this rate. Do not leave an exposed vertical edge perpendicular to the direction of travel.

Mill the surface to a smoothness such that a 10 foot metal straightedge, measured at right angle and parallel to the centerline, does not have more than a 1/4 inch surface deviation between any two contact points.

Use a rotary broom and vacuum immediately behind the milling operations to remove and completely recover all loose material. Minimize the escape of dust into the air. Dispose of recovered milled material in accordance with Subsection 202.04(a) or as SHOWN ON THE DRAWINGS.

413.04 Acceptance. Asphalt pavement milling will be evaluated for acceptance based on visual and measured conformance based upon contract requirements and customary construction tolerances.

Measurement

413.05 Method. Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment

413.06 Basis. The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

Pay		**Pay Unit**
413(01)	Asphalt pavement milling	Square Yard
413(02)	Asphalt pavement milling	Mile

Section 414 - Asphalt Pavement Joint & Crack Treatments

Description

414.01 Work. Cut or rout open cracks. Clean and either seal or fill joints and cracks in asphalt pavement. Joint sealant classes are designated in Subsection 414.02.

Materials

414.02 Requirements. Ensure that material conforms to specifications in the following subsections:

Asphalt Cement	702.01
Backer Rod	712.01(g)
Blotter	703.12
Crack Fillers	712.01(a)(3) and (4)
Emulsified Asphalt	702.03
Fine Aggregate for Portland Cement Concrete	703.01
Joint Sealant, Class 1	712.01(a)(1)
Joint Sealant, Class 2	712.01(a)(2)
Joint Sealant, Class 3	712.01(f)
Slurry Seal	409.02 and 409.03

Construction

414.03 Equipment. Furnish equipment with the features and capabilities shown below:

(a) Power Saw & Blades. A saw and blades of such size and configuration that saw cuts can be made with one pass to the required depth and width. Spacers are not allowed.

(b) Router. A power rotary impact router or vertical spindle router capable of cleaning cracks or joints to the required depth and width.

(c) Hot-Compressed Air Lance. A lance capable of providing clean, oil-free compressed air at a volume of 100 cubic feet/min, at a pressure of 120 psi, and at a temperature of 2,000 °F.

(d) Application Wand. A crack sealant applicator wand attached to a heated hose that is attached to a heated sealant chamber.

(e) Heating Kettle. An indirect-heating-type double boiler with the space between the inner and outer shells filled with oil or other heat transfer medium capable of constant agitation and able to maintain the temperature of the sealant within manufacturer's tolerances. Provide an accurate and calibrated thermometer with a range from 200 °F to 600 °F in 5 °F graduations. Locate the thermometer such that the temperature of the joint sealant may be safely checked.

(f) Squeegee. Provide a hand-held squeegee for ensuring that the crack is filled to the existing surface.

414.04 Joint Cutting & Cleaning. Saw cut or rout, clean, and seal joints in a continuous operation. Either dry or wet cutting is allowed. The depth and width of joint cutting will be as SHOWN ON THE DRAWINGS.

Clean dry-sawed joints with a stream of air sufficient to remove all dirt, dust, or deleterious matter adhering to the joint walls or remaining in the joint cavity. Blow or brush dry material off the pavement surface.

Immediately after sawing, clean wet-sawed joints with a water blast, 50 psi minimum, to remove any sawing slurry, dirt, or deleterious matter adhering to the joint walls or remaining in the joint cavity. Immediately flush all sawing slurry from the pavement surface. Blow wet-sawed joints with air to dry joint surfaces.

Do not allow traffic to knead together or damage the sawed joints. If cleaning operations cause interference with traffic, provide protective screening.

414.05 Joint Cleaning & Sealing. If necessary, clean the joint according to Subsection 414.06. Place the sealant when the pavement surface temperature is 40 °F and rising. Discontinue operations when weather conditions detrimentally affect the quality of forming joints and applying sealant.

Submit a copy of, and adhere to, the manufacturer's recommendations for heating and applying the sealant. Heat the sealant in a heating kettle. Do not heat the sealant above the safe heating temperature recommended by the manufacturer. Do not hold the material at the pouring temperature for more than 6 hours, and do not reheat the material.

Place a backer rod in the bottom of the cut or routed joint. Ensure that the size of the backer rod conforms to Table 712-2.

Seal the joints with an applicator wand when the sealant material is at the pouring temperature. Heat or insulate the applicator wand to maintain the pouring temperature of the sealant during placing operation. Return the applicator wand to the machine and recirculate the joint sealant material immediately after sealing each joint.

Immediately screed the joint sealant to the elevation of the existing surface. Use a squeegee to ensure that a 3 inch-wide band is centered on the finished sealed crack.

Wait for the sealant to be tack free before opening the joint to traffic. Do not spread blotter on the sealed joints to allow early opening to traffic.

414.06 Crack Cleaning & Filling. Clean the existing surface of all loose material, dirt, or other deleterious substances by brooming, flushing with water, or other approved methods. Dry cracks before sealing.

When using the hot-compressed air lance, keep it moving so as not to burn the surrounding pavement and the crack. Place and finish sealant within 5 minutes after heating with the hot-compressed air lance.

For cracks ¼ inch or less, fill with CSS–1, SS–1, or crack filler. Submit a copy of, and adhere to, the manufacturer's recommendations for heating and applying the crack filler. Use a squeegee to ensure that a 3 inch-wide band is centered on the finished sealed crack. Cover the sealed crack with a light application of blotter.

For cracks with a width greater than ¼ inch and less than 1 inch, fill with either a slurry seal mixture, fine aggregate-asphalt cement mixture, or fine aggregate– emulsified asphalt mixture. Have the mixture approved by the CO. Use a squeegee or other suitable equipment to force the mixture into the cracks. Immediately screed the sealant or asphalt mixture to the elevation of the existing surface. Cover the sealed crack with a light application of blotter.

For cracks with a width greater than 1 inch, fill flush to the existing surface with either hot or cold asphalt concrete mix. Have the mixture approved by the CO.

414.07 Resealing Defective Joints or Cracks. Reseal areas that exhibit adhesion failure, damage, missed areas, foreign objects in the sealant, or other problems that will accelerate failure.

414.08 Acceptance. Material for joint sealant and crack filler will be evaluated under Subsection 106.05.

Measurement

414.09 Method. Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment

414.10 Basis. The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

Pay Item		Pay Unit
414(01)	Joint cutting and cleaning	Liner Foot
414(02)	Joint cleaning and sealing	Linear Foot
414(03)	Joint sealant, class _____	Gallon
414(04)	Joint sealant, class _____	Pound

414(05) Joint sealant, class _____ .....Linear Foot

414(06) Crack cleaning and filling .....Linear Foot

414(07) Crack filler .....Gallon

414(08) Crack filler .....Pound

414(09) Crack filler .....Linear Foot

Section 415 - Paving Geotextiles

Description

415. 01 Work. Furnish and place a paving geotextile and asphalt sealant between pavement layers to form a waterproofing and stress-relieving membrane within the pavement structure. Have the surface approved by the CO in writing prior to placing the asphalt sealant and paving geotextile.

Materials

415.02 Requirements. Provide material that conforms to specifications in the following subsections:

Asphalt Cement	702.01
Choker Aggregate	703.12
Emulsified Asphalt	702.03
Geotextiles, Type VI	714.01

Construction

415.03 Surface Preparation. Clean the surface on which the geotextile is to be placed using a power broom and/or power blower. Fill cracks that exceed ¼ inches according to Subsection 414.06. Allow crack filler and patches to cure before placing the geotextile. Remove all foreign and loose material.

415.04 Weather Limitations. Apply asphalt sealant and paving geotextile on a dry surface when the pavement surface temperature is at least 55 °F and rising.

415.05 Asphalt Sealant Application. Use asphalt cements within a temperature range of 290 °F to 325 °F. Use emulsified asphalts within a temperature range of 130 °F to 160 °F.

Apply the asphalt sealant to the pavement surface in accordance with Subsection 410.08 at a rate of 0.20 to 0.30 Gal/yd^2 for asphalt cement and 0.30 to 0.45 Gal/yd^2 for emulsified asphalt.

Spray the asphalt sealant 6 inches wider than the paving geotextile. Do not apply the asphalt sealant any farther in advance of the paving geotextile placement than can be maintained free of traffic.

Where emulsified asphalt is used, allow the emulsion to completely break before placing the paving geotextile.

Where asphalt cement is used, place the paving geotextile immediately after the asphalt cement is applied.

415.06 Paving Geotextile Placement. Place the paving geotextile onto the asphalt sealant with minimal wrinkling. Slit, lay flat, and tack all wrinkles or folds higher than

1 inch. Broom and/or roll the paving geotextile to maximize fabric contact with the pavement surface.

At geotextile joints, overlap the geotextile 6 inches to ensure full closure. Overlap transverse joints in the direction of paving to prevent edge pickup by the paver. Apply additional asphalt sealant to paving geotextile overlaps to ensure proper bonding of the double fabric layer.

If asphalt sealant bleeds through the fabric, treat the affected areas with choker aggregate. Minimize traffic on the geotextile. If circumstances require traffic on the membrane, apply choker aggregate and place signs that read "*Slippery When Wet*." Broom the excess choke from the geotextile surface before placing the overlay. Repair all damaged fabric before placing the overlay. Apply a light tack coat in accordance with Section 407 before placing the overlay. To avoid damaging the geotextile, do not turn equipment on the geotextile.

Place a hot asphalt concrete overlay within 48 hours after placing the paving geotextile. Limit the laydown temperature of the mix to a maximum of 330 °F, except when the paving geotextile is composed of polypropylene fibers. In this case, limit the laydown temperature of the mix to a maximum of 300 °F.

415.07 Acceptance. Asphalt cement and emulsified asphalt will be evaluated for acceptance under Subsection 106.05.

Blotter will be evaluated for acceptance under Subsection 105.03.

Paving geotextile material will be evaluated for acceptance under Subsection 714.01.

Provide the minimum number of samples specified in Table 410-4.

Measurement

415.08 Method. Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment

415.09 Basis. The accepted quantities will be paid for at the contract unit price for each PAY ITEM DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

Pay Item		Pay Unit
415(01)	Paving geotextile	Square Yard
415(02)	Asphalt sealant	Ton
415(03)	Choker aggregate	Ton

Section 416 - Asphalt Pavement Patching

Description

416.01 Work. Perform deep patching, skin patching of asphalt surfaces, and patching of asphalt berms. Prepare the area to be patched, and furnish and place all necessary materials.

Materials

416.02 Requirements. Ensure that asphalt materials are of the type and grade SHOWN ON THE DRAWINGS, and that they meet the requirements specified in the following subsections:

Asphalt Cement.....702.01
Cutback Asphalt 702.02
Emulsified Asphalt 702.03

Ensure that mixing temperatures meet the requirements specified in Subsection 702.04; that aggregates meet the requirements specified in Subsection 703.07, except for gradation; and that fabric meets the requirements specified in Subsection 714.01.

416.03 Job-Mix Formula. Prior to producing asphalt concrete mixtures, submit in writing a proposed job-mix formula and supporting documentation for each mixture to the CO for use in setting the job-mix formula to be used with the proposed materials.

After reviewing the proposed job-mix formula, the CO will determine the final values for the job-mix formula to be used and notify the Contractor in writing.

Construction

416.04 Deep Patching. Remove surface course and base course materials above the subgrade to a minimum depth of 2 inches, or as necessary to reach firm support. If firm support for a patch is unavailable, notify the CO prior to placing any material.

Trim or mill the edges of the prepared hole to form a vertical face in unfractured asphalt surfacing. Make the prepared hole rectangular in shape, and clean it of all loose material. When the hole is dry, spray the bottom and faces with an emulsified asphalt.

Immediately patch or barricade prepared sites.

Place the asphalt concrete mixture in layers not exceeding 4 inches. Thoroughly compact each layer with hand or mechanical tampers or rollers.

Compact the finished surface with a steel-wheel roller or vibratory plate compactor. For hot asphalt concrete mixtures, compact the mix while it is above 230 °F. Ensure that the compacted patch, upon completion, is approximately 1/8 to ¼ inch above the level of the

adjacent pavement. Seal the edges of the completed patch with emulsified asphalt, and blot with fine sand.

When SHOWN ON THE DRAWINGS and DESIGNATED IN THE SCHEDULE OF ITEMS, use a geotextile saturated with rubberized asphalt to strengthen the pothole area. Ensure that the geotextile has a minimum grab strength of 20 pounds. Prepare the surface on which the fabric is placed by digging out and patching as described above, or by cleaning the surface, removing vegetation, and filling all cracks more than ¼ inch wide with an approved crack-filling material. Remove excess crack-filling material.

Place the fabric membrane over the repaired area. Extend the fabric a minimum of 6 inches beyond the repaired or patched area onto sound adjoining pavement. Use a minimum of 2 inches overlap where adjacent fabric panels are needed to cover the repaired area.

416.05 Skin Patches. Prior to skin patching, patch all potholes.

Treat minor depressions, light raveling, or surface checking at scattered locations SHOWN ON THE DRAWINGS or marked on the ground by applying a skin patch.

Prior to skin patching, clean the surface of loose and deleterious material, and spray it with emulsified asphalt at the rate ordered by the CO. Do not place mixture until authorized by the CO.

Uniformly distribute asphalt concrete mixture in layers not to exceed 2 inches compacted depth. Feather the edges of skin patches. When multiple layers are necessary, offset all joints at least 6 inches between layers.

Compact each layer with a 8 to 10-ton steel roller. For hot asphalt concrete mixtures, compact the mix while it is above 230 °F.

Ensure that the completed patch does not have abrupt transitions that could adversely affect the steering of a passenger car traveling across the area. Provide transition tapers for skin patches that are 4 inches per 1/32-inch thickness of patch in the direction on travel.

416.06 Asphalt Berm. Remove damaged segments of berm and bevel exposed ends at approximately 45° from vertical. Clean and patch the berm foundation as necessary. Coat the foundation and joining surfaces with emulsified asphalt. Place and compact asphalt mix to conform with the shape of the undamaged segment.

416.07 Waste Material. Dispose of all materials removed from potholes, patches, and berms in accordance with Subsection 202.04(a).

Measurement

416.08 Method. Use the method of measurement that is DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment

416.09 Basis. The accepted quantities will be paid for at the contract unit price DESIGNATED IN THE SCHEDULE OF ITEMS.

Payment will be made under:

Pay Item		Pay Unit
416(01)	Hot asphalt concrete mixture	Ton
416(02)	Deep patch hot asphalt concrete mixture	Ton
416(03)	Skin patch hot asphalt concrete mixture	Ton
416(04)	Cold asphalt concrete mixture	Ton
416(05)	Rubberized asphalt saturated geotextile	Square Yard